AIA File No. 10-C

CONCRETE MASONRY Handbook

for Architects and Builders

PORTLAND CEMENT ASSOCIATION

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for Architects and Builders

PORTLAND CEMENT ASSOCIATION
33 West Grand Avenue • Chicago 10, Illinois

The activities of the Portland Cement Association, a national organization, are limited to scientific research, the development of new or improved products and methods, technical service, promotion and educational effort (including safety work), and are primarily designed to improve and extend the uses of portland cement and concrete. The manifold program of the Association and its varied services to cement users are made possible by the financial support of over 65 member companies in the United States and Canada, engaged in the manufacture and sale of a very large proportion of all portland cement used in these two countries. A current list of member companies will be furnished on request.

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FOREWORD

THIS HANDBOOK is dedicated to those architects, engineers, engineering colleges, research organizations, financing agencies, builders, concrete products manufacturers, masons and other craftsmen whose energy, cooperation and foresight have made possible the remarkable development of the concrete masonry industry. Concrete masonry has become increasingly important as a construction material. The annual use exceeds the combined wall volume of all other types of unit masonry construction according to information from the July 1949 issue of "Construction and Construction Materials—Industry Report," published by the U.S. Department of Commerce.

Along with the rapid increase in use of concrete masonry there have been important technological developments in the manufacture and utilization of the units. This handbook sets forth concisely and graphically the latest recommended practices in concrete masonry construction. Technical information developed in the field and in the research laboratory is included.

These data are presented to assist architects, engineers and builders in designing or constructing concrete masonry buildings that meet modern requirements which will vary with the purpose of the building. In all buildings, firesafety, durability and economy are of supreme importance. Additional requirements may be beauty, comfort, utility, quietness and good acoustics whether the structure be a residence, school, church, commercial or industrial building.

Concrete masonry walls properly designed and constructed will satisfy these varied requirements.

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The drawings in this publication are typical designs and should not be used as working drawings. They are intended to be helpful in the preparation of complete plans which should be adapted to local conditions and should conform with legal requirements. Working drawings should be prepared and approved by a qualified engineer or architect.

CHARACTERISTICS OF CONCRETE MASONRY UNITS

CONCRETE MASONRY units are designed and made for use in all types of masonry construction. Some of the uses are:

- Exterior load-bearing walls (below and above grade)
- Interior load-bearing walls
- Fire walls, party walls, curtain walls
- Partition and panel walls
- Backing for brick, stone, stucco and other facings
- Fireproofing over steel structural members
- Firesafe walls around stair wells, elevators and other enclosures
- Piers, pilasters, columns
- Retaining walls and garden walls
- Chimneys and fireplaces (indoor and outdoor)
- Concrete floor units

Concrete masonry building units are designated as:

1. **Hollow load-bearing concrete block**
2. **Solid load-bearing concrete block**
3. **Hollow non-load-bearing concrete block**
4. **Concrete building tile**
5. **Concrete brick**

Heavyweight and Lightweight Units

The five types of units listed above are regularly made with either heavyweight or lightweight aggregates and are known as heavyweight and lightweight units respectively. A hollow load-bearing concrete block of 8x8x16-in. nominal size will weigh from approximately 40 to 50 lb. when made with heavyweight aggregate, and from 25 to 35 lb. when made with lightweight aggregate. Heavyweight units are made with such aggregates as sand, gravel, crushed stone and air-cooled slag. Lightweight units are made with coal cinders, expanded shale, clay or slag, and natural lightweight materials such as volcanic cinders, pumice and scoria. Heavyweight and lightweight units are used for all types of masonry construction. Whether the designer or builder chooses heavyweight or lightweight units generally depends on their availability and the requirements of the structure under consideration.

Solid and Hollow Units

A solid concrete block is defined in the American Society for Testing Materials specifications as a unit in which the core area is not more than 25 per cent of the gross cross-sectional area. Concrete brick are generally solid and are sometimes available with a recessed pocket often called a "frog."

A hollow concrete block is a unit having a core area greater than 25 per cent of its gross cross-sectional area. Generally, the core area of hollow units will be from 40 to 50 per cent of the gross area.

Sizes and Shapes

Concrete building units are made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, partition, and concrete floor units. All are made in both full- and half-length units. Various sizes and shapes are illustrated in Fig. 1.

Concrete unit sizes are usually referred to by their nominal dimensions. Thus, a unit measuring 7⅝ in. wide, 7⅝ in. high, and 15⅝ in. long is known as an 8x8x16-in. unit. When it is laid in a wall with ⅜-in. mortar joints, this unit will occupy a space exactly 16 in. long and 8 in. high. This is in accordance with the modular coordination of design based on a 4-in. module. In addition, there is a wide variety of non-modular size units.

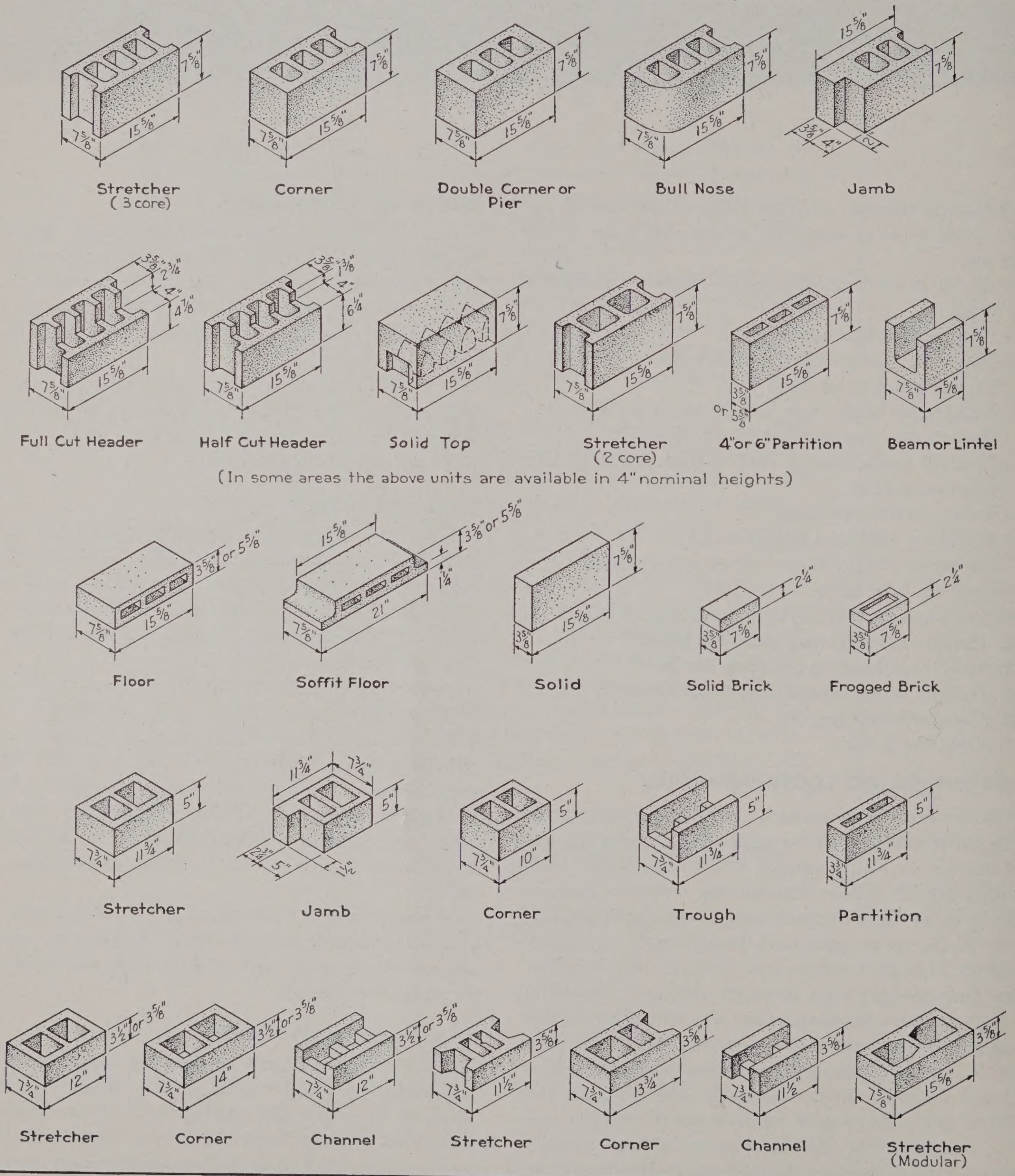
Manufacturers will supply a schedule of the sizes and shapes which they have available. *Architects are urged to determine in advance the sizes of units which are available for the proposed construction.*

Specifications and Codes

Concrete masonry units are made to comply with the requirements of local building codes, Federal Specifications, or the applicable specifications of the American Society for Testing Materials or other specifying agencies. A summary of some of these specifications covering requirements such as compressive strength, absorption and moisture content is given in Table 1.

TYPICAL SHAPES AND SIZES OF CONCRETE MASONRY UNITS

Dimensions shown are actual unit sizes. A 7⅝" x 7⅝" x 15⅝" unit is commonly known as an 8" x 8" x 16" concrete block.
Half length units are usually available for most of the units shown below. See concrete products manufacturer for shapes and sizes of units locally available.



Stretcher (3 core)
Corner
Double Corner or Pier
Bull Nose
Jamb

Full Cut Header
Half Cut Header
Solid Top
Stretcher (2 core)
4" or 6" Partition
Beam or Lintel

(In some areas the above units are available in 4" nominal heights)

Floor
Soffit Floor
Solid
Solid Brick
Frogged Brick

Stretcher
Jamb
Corner
Trough
Partition

Stretcher
Corner
Channel
Stretcher
Corner
Channel
Stretcher (Modular)

Figure 1.

TABLE 1—Summary of Physical Requirements for Various Types of Concrete Masonry Units

Specification, serial designation, and latest revised date	Minimum face-shell thickness, in.	Compressive strength, minimum, psi, average gross area		Water absorption, maximum, lb. per cu.ft. of concrete, average of 5 units	Moisture content, maximum, per cent of total absorption, average of 5 units
		Average of 5 units	Individual unit		
Hollow load-bearing concrete masonry units ASTM C90,1944†	1¼ or over:				
	Grade A*	1000	800	15	40
	Grade B**	700	600	—	40
	Under 1¼ and over ¾	1000	800	15	40
Hollow non-load-bearing concrete masonry units ASTM C129, 1939†	Not less than ½	350	300	—	40
Solid load-bearing concrete masonry units ASTM C145, 1940***†					
Grade A	—	1800	1600	15	40
Grade B	—	1200	1000	15	40
Concrete units; masonry, hollow Federal SS-C-621, 1935				Average of 3 units	Average of 3 units
Load-bearing units	1¼ or more	700	600	16	40
	¾ to 1¼	1000	800	16	40
Non-load-bearing units	Not less than ¾	350	—	—	40

		Compressive strength, minimum, psi, average gross area (brick flatwise)		Modulus of rupture, minimum, psi, (brick flatwise)	
		Average of 5 brick	Individual	Average of 5 brick	Individual
Concrete building brick ASTM C55, 1937†					
Grade A	—	2500	2000	450	300
Grade B	—	1250	1000	300	200

*For use in exterior walls below grade, and for unprotected exterior walls above grade.

**For general use above grade where protected from the weather with two coats of portland cement paint or other satisfactory waterproofing treatment approved by the purchaser.

***Units with 75 per cent or more net area. The classification is based on strength and does not necessarily measure weather resistance.

†Tentative revisions to these specifications are shown in the 1950 Supplement to the *Book of ASTM Standards*, Part 3, pp. 347–349 incl.

Compressive strength requirements provide a measure of concrete masonry's capacity to carry loads and withstand structural stresses with an adequate factor of safety. The absorption requirements provide a measure of the density of the concrete. The moisture content requirements are intended to indicate whether the unit is sufficiently dry for use in wall construction. In common with a number of building materials, concrete shrinks slightly with the loss of moisture down to an air-dry condition. When moist units are placed in a wall and this natural shrinkage is restrained, as it often is, tensile and shearing stresses are developed which may cause cracks in the walls. Hence, it is important that architects and builders insist that the units used be dried down to at least the moisture content limitations of applicable specifications.

Where concrete masonry walls will be exposed to low relative humidities, such as may be found in interiors of heated buildings or in areas of the country having exceptionally dry climates, it is desirable that the block, at the time of laying, be dried down to approximately the average air-dry condition to which the finished walls will be exposed in service.

An inexpensive and efficient device for drying block consists of a combination oil or gas burning heater and

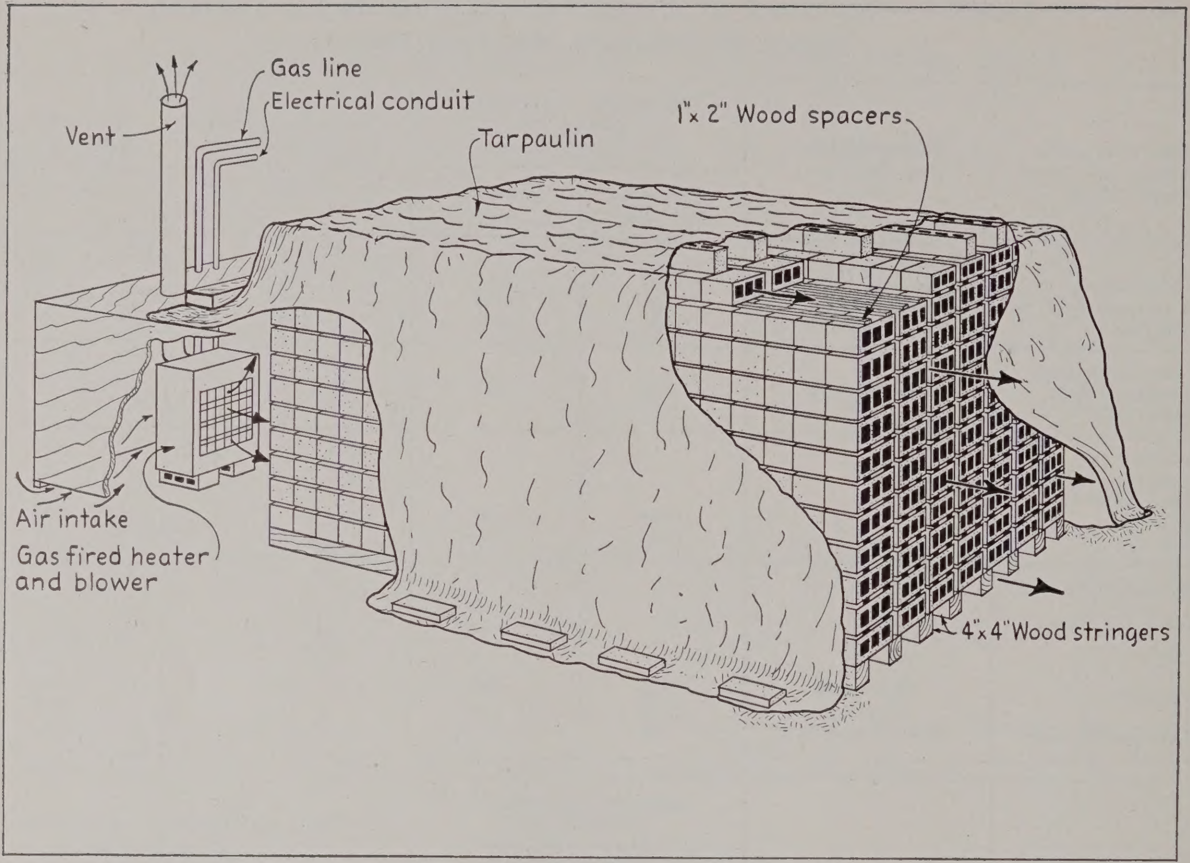


Fig. 2—A suggested method for drying concrete block. It can be used indoors or outdoors at plant or job site.

blower (see Fig. 2). Block are stacked on their sides in front of the heater and blower to permit air to be blown through the cores. Block courses are separated vertically with 1x2-in. wood strips and are spaced 1 in. apart horizontally to aid free circulation of air around each unit. Experience will show how large a stack of block can be dried at one time. As a trial setup, it is suggested the stack be 4 block wide, 6 courses high and 16 ft. long. A light tarpaulin-covered framework 6 in. higher, 12 in. wider, and as long as the stack of block plus the length of the blower unit provides satisfactory housing for the drying device. This method of drying works equally well indoors or outdoors and can readily be used in the plant or at the job site.

Concrete masonry units stored on the job site should be protected against wetting by rain or snow.

Color and Surface Texture

Some variation in color and texture is often desirable for appearance. However, concrete masonry units used in constructing exposed walls should be free from stains and discoloration, blemishes or defects which would detract from the desired appearance of the finished wall. Variation in texture is obtained by controlling the gradation of aggregate and other operations in the manufacture of the units. Hence, surface textures can be made fine, medium coarse or coarse according to requirements.

PROPERTIES OF CONCRETE MASONRY WALLS

Building codes and specifications govern the maximum allowable compressive working stress on all types of masonry construction. Maximum allowable compressive working stresses in walls constructed of hollow concrete masonry units, as specified in the American Standard Building Code Requirements for Masonry approved by the American Standards Association, and in the National Building Code recommended by the National Board of Fire Underwriters, are 70 psi for walls laid up with the mortars shown in Table 15, page 26, for ordinary service and 85 psi for the mortars shown for walls subject to extremely heavy loads, etc.

Strength and Structural Stability

The allowable wall stresses provide an ample factor of safety when using concrete masonry units complying with the compressive strength requirements of specifications shown in Table 1.

Comprehensive tests conducted by the University of Illinois* and by the Portland Cement Association** have established the relationship between the compressive strength of hollow concrete masonry units and the walls in which they are laid. These tests disclosed that the compressive strength of axially loaded walls in pounds

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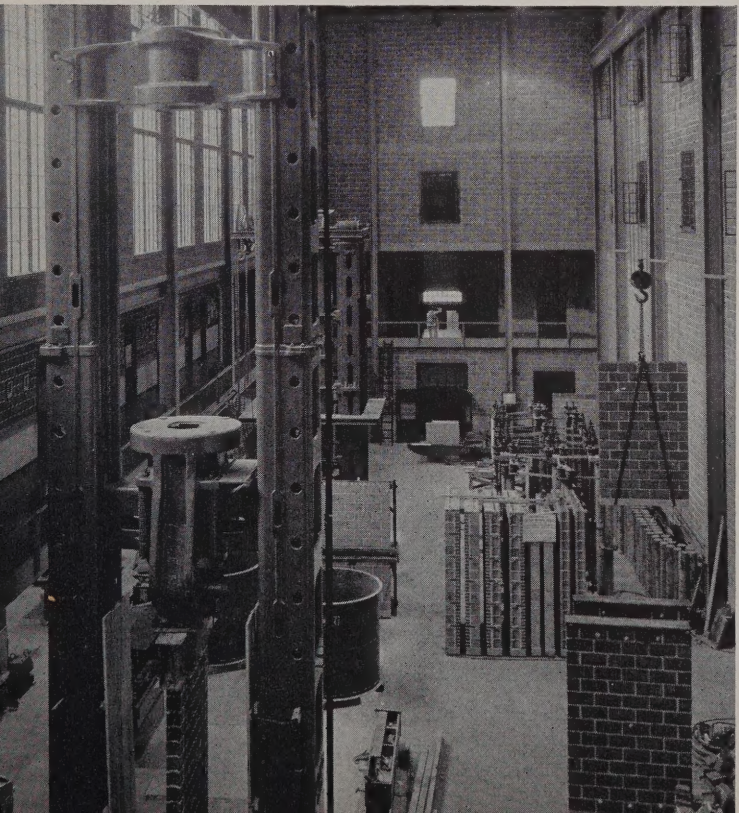
*"Strength and Stability of Concrete Masonry Walls," by F. E. Richart, R. B. B. Moorman and P. M. Woodworth, University of Illinois, *Engineering Experiment Station Bulletin No. 251.*

**"Tests of the Fire Resistance and Stability of Walls of Concrete Masonry Units," by Carl A. Menzel, *Proceedings*, American Society for Testing Materials, Vol. 31, part 2, p. 607.

Materials Testing Laboratory of University of Illinois tests compressive strength of concrete masonry walls.



Concrete masonry wall being tested for flexural strength at University of Illinois.

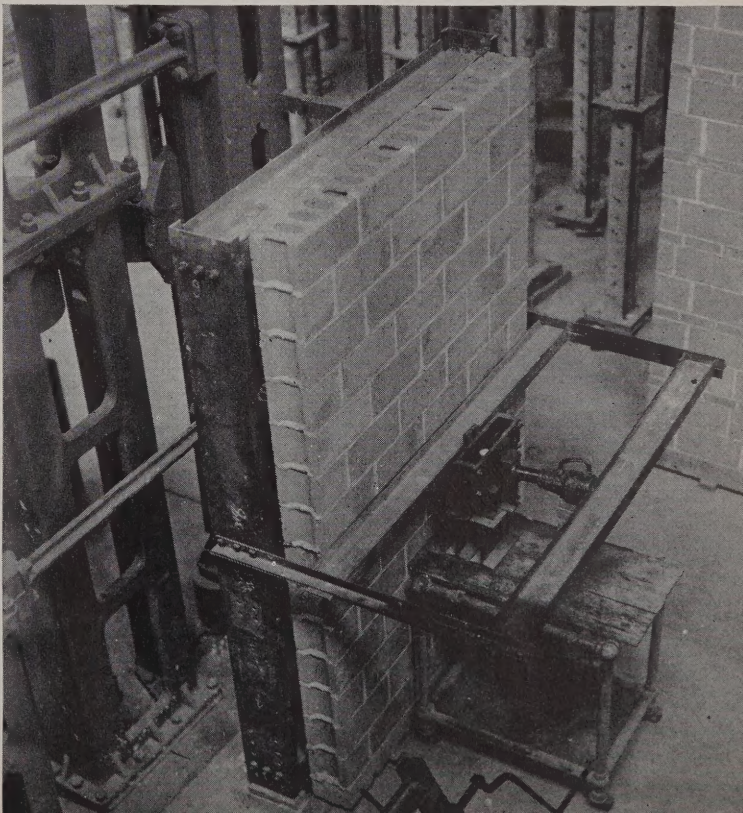
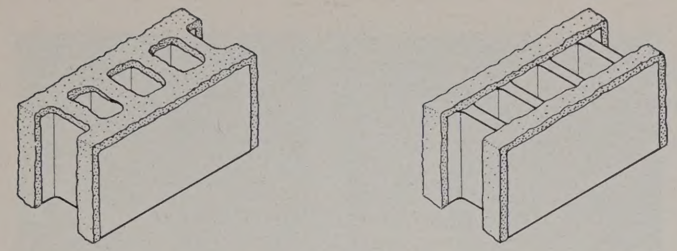


TABLE 2—Coefficients of Heat Transmission (*U*) for Various Walls

Basic wall construction*		Interior finish			
		Plain wall no plaster	½-in. plaster on:		
			Wall direct	¾-in. furring with:	
				⅜-in. plaster-board	½-in. rigid insulation
Concrete masonry (cores not filled)	8-in. sand and gravel or limestone	0.53	0.49	0.31	0.22
	8-in. cinder	0.37	0.35	0.25	0.19
	8-in. expanded slag, clay or shale	0.33	0.32	0.23	0.18
	12-in. sand and gravel or limestone	0.49	0.45	0.30	0.22
	12-in. cinder	0.35	0.33	0.24	0.18
	12-in. expanded slag, clay or shale	0.32	0.31	0.23	0.18
Concrete masonry (cores filled with insulation)**	8-in. sand and gravel or limestone	0.39	0.37	0.26	0.19
	8-in. cinder	0.20	0.19	0.16	0.13
	8-in. expanded slag, clay or shale	0.17	0.17	0.14	0.12
	12-in. sand and gravel or limestone	0.34	0.32	0.24	0.18
	12-in. cinder	0.20	0.19	0.15	0.13
	12-in. expanded slag, clay or shale	0.15	0.14	0.12	0.11
Cavity walls (with 2-in. or larger cavity. Cavity not filled with insulation)	10-in. wall of two 4-in. sand and gravel or limestone units	0.34	0.33	0.24	0.18
	10-in. wall of two 4-in. cinder, expanded slag, clay or shale units	0.26	0.24	0.19	0.15
	10-in. wall of 4-in. face brick and 4-in. sand and gravel or limestone units	0.38	0.36	0.25	0.19
	10-in. wall of 4-in. face brick and 4-in. cinder, expanded slag, clay or shale unit	0.33	0.31	0.23	0.18
	14-in. wall of 4-in. face brick and 8-in. sand and gravel or limestone units	0.33	0.31	0.23	0.18
	14-in. wall of 4-in. face brick and 8-in. cinder, expanded slag, clay or shale unit	0.26	0.25	0.19	0.16
	14-in. wall of 4-in. and 8-in. sand and gravel or limestone units	0.30	0.28	0.21	0.17
	14-in. wall of 4-in. and 8-in. cinder, expanded slag, clay or shale units	0.22	0.21	0.17	0.14
4-in. face brick plus:	4-in. sand and gravel or limestone unit	0.53	0.49	0.31	0.23
	4-in. cinder, expanded slag, clay or shale unit	0.44	0.42	0.28	0.21
	4-in. common brick	0.50	0.46	0.30	0.22
	8-in. sand and gravel or limestone unit	0.44	0.41	0.28	0.21
	8-in. cinder, expanded slag, clay or shale unit	0.31	0.30	0.22	0.17
	8-in. common brick	0.36	0.34	0.24	0.19
	1-in. wood sheathing, paper, 2x4 studs, wood lath and plaster	—	0.27	0.27	0.20
4-in. common brick plus:	4-in. sand and gravel or limestone unit	0.45	0.42	0.28	0.21
	4-in. cinder, expanded slag, clay or shale unit	0.38	0.36	0.26	0.19
	8-in. sand and gravel or limestone unit	0.37	0.35	0.25	0.19
	8-in. cinder, expanded slag, clay or shale unit	0.28	0.27	0.20	0.16
	8-in. common brick	0.31	0.30	0.22	0.17
	1-in. wood sheathing, paper, 2x4 studs, wood lath and plaster	—	0.25	0.25	0.19
Wood frame	wood siding, 1-in. wood sheathing, 2x4 studs, wood lath and plaster	—	0.25	0.24	0.19

*All concrete masonry shown in this table are hollow units. All concrete masonry wall surfaces exposed to the weather have two coats of portland cement base paint. Surfaces of all walls exposed to the weather subject to a wind velocity of 15 miles per hour.

**Values based on dry insulation. The use of vapor barriers or other precautions must be considered to keep insulation dry.



Full mortar bedding

Face-shell mortar bedding

Fig. 3—Examples of full bedding and face-shell mortar bedding.

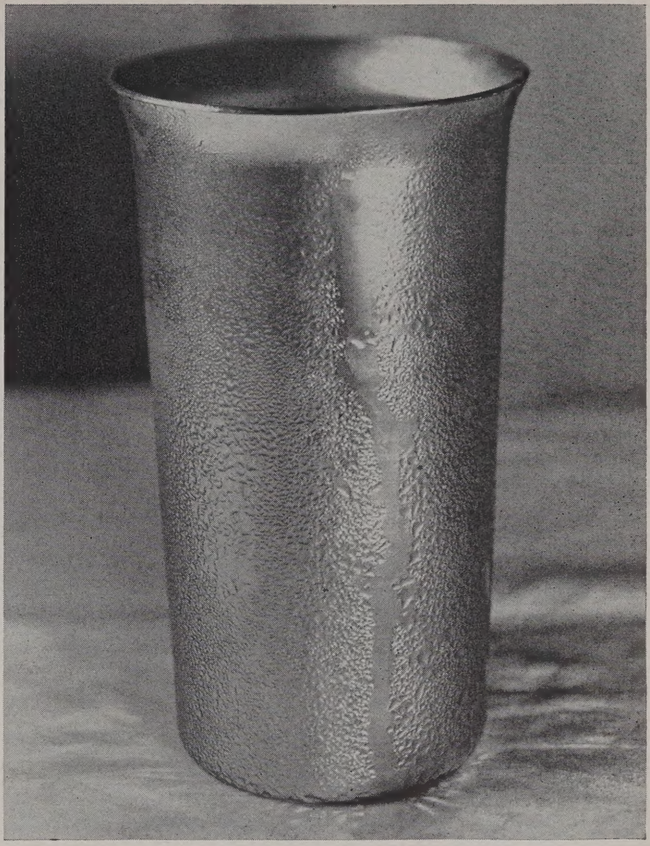
per square inch was approximately 42 per cent of the compressive strength of the unit when laid with face-shell mortar bedding and 53 per cent when laid with full-mortar bedding. See Fig. 3 for examples of full bedding and face-shell mortar bedding.

Thus, a wall constructed of hollow concrete masonry units having a minimum compressive strength of 700 psi and laid up with face-shell mortar bedding with the wall loaded axially will have a compressive wall strength of 0.42 × 700, or 294 psi. Using an allowable compressive working stress of 70 psi, a wall having a strength of 294 psi will have a factor of safety of 4.2. Similarly, a wall constructed with 1000 psi block will have a factor of safety of 6. Both exceed the factor of safety of 4 generally considered ample for masonry wall construction.

Insulation Value of Concrete Masonry

The insulation value of concrete masonry has been definitely determined by tests conducted at the University of Minnesota.* Based on these tests, Table 2 shows the insulation values (heat transmission U) for various types of concrete masonry walls as well as for other types of common wall construction. The overall coefficient of heat transmission U represents the amount of heat transmitted in British thermal units (Btu) per hour, per square foot of wall, for each degree difference in temperature (Fahrenheit) between the air on the warm and cool sides of the wall. A study of the table will show how the insulating value of concrete masonry walls is affected by type of construction, type of aggregate used, kind of wall finish, insulating fill in cores and by air spaces, etc.

Controlling Condensation on Walls



Beads of water on the outside of this tumbler of ice water are caused by condensation of water vapor in the air as it comes in contact with the cold surface.

Wall insulation helps prevent condensation on the interior surfaces of outside walls. Just as a pitcher of cold water will sweat on a humid day, so may condensation occur in any type of construction—brick, wood, metal, stone or concrete—if sufficient insulation is not provided. Sweating occurs when the surface temperature of a wall falls below the dew point of the air. The dew point at which condensation takes place varies with the temperature of the air and the amount of water vapor in the air. For example, with a room temperature of 70 deg. F. and a relative humidity of 60 per cent, the dew point is 55.6 deg. F. To prevent condensation under these conditions, wall surface temperatures must be kept above 55.6 deg. F.

Information on calculating heat losses and wall temperatures for many other types of wall construction is contained in the *Heating, Ventilating, Air-Conditioning Guide* published by the American Society of Heating and Ventilating Engineers. Similar information as it applies to concrete masonry walls is given in the paper "Thermal Insulation of Concrete Homes,"** and in *How to Calculate Heat Transmission Coefficients and Vapor Condensation Temperatures of Concrete Masonry Walls* published by the Portland Cement Association. Table 3 gives typical maximum U values specified by the Federal Housing Administration

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*"Thermal Properties of Concrete Construction," by F. B. Rowley, A. B. Algrena nd C. C. Carlson, *Heating, Piping and Air Conditioning*, January 1936. "Thermal Properties of Concrete Construction (Part 2)," by F. B. Rowley, A. B. Algren and Robert Lander, *Heating, Piping and Air Conditioning*, November 1936.

***Journal*, American Concrete Institute, Vol. 19, No. 9, p. 849.

TABLE 3—Typical FHA Heat Transmission Coefficient Limitations for Walls for One or Two Living Units

FHA insuring office	Overall coefficient of heat transmission (*U* factor)*
Arizona (Phoenix)	0.50
Florida (Jacksonville)	0.33
Illinois (Chicago)	0.27
Montana (Helena)	0.13
New York (New York)	0.30
Oregon (Portland)	0.25
Minnesota (Minneapolis)	0.19
Texas (Dallas)	0.35

*From section 402-A of FHA *Minimum Property Requirements for Properties of One or Two Living Units* for various insuring offices, July 1948.

for walls of houses in a number of cities representative of the varied climatic conditions in the United States.

Fire Resistance of Concrete Masonry

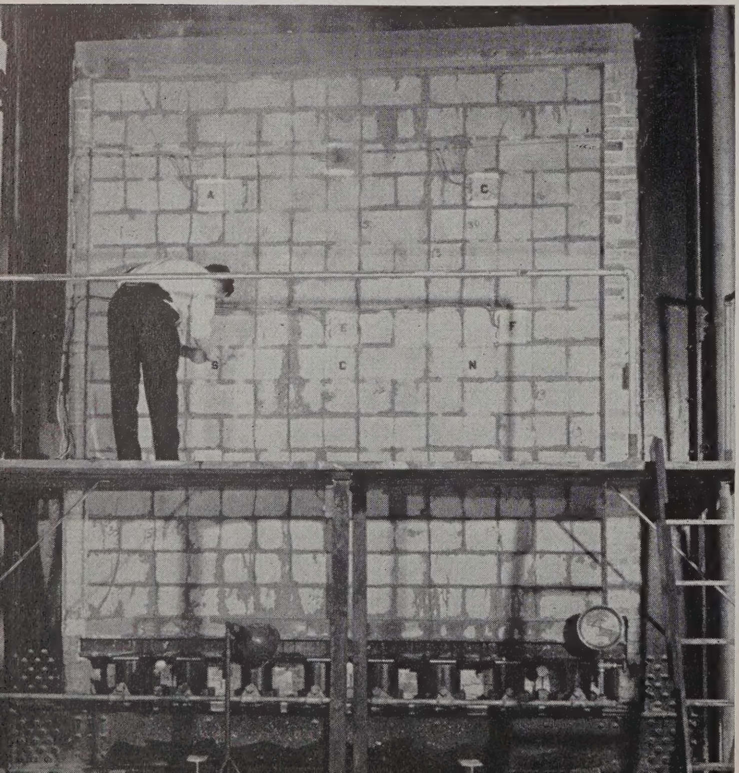
The fire resistance ratings specified by building codes for masonry walls will vary with the type of building, its occupancy and the fire zone in which the structure is located.

The fire resistance ratings of walls constructed of hollow concrete masonry units have been based on numerous fire tests made at the Underwriters' Laboratories, Inc., National Bureau of Standards, and at the Portland Cement Association. Based on a study of these fire tests, the estimated fire resistance ratings of hollow concrete masonry walls and partitions are shown in Table 4 as taken from the National Building Code (1949) recommended by the National Board of Fire Underwriters. From these tests it was found that the thickness of the hollow space is a relatively minor factor in the fire resistance of the unit. Comparative tests have indicated that it is the equivalent thickness of solid material in the unit rather than the total thickness of the unit which is the principal factor.

Fire hose stream test being applied to incandescent face of concrete masonry wall immediately after it is removed from furnace.

How Fire Tests are Made

Fire tests are made on walls approximately 10 ft. wide and 11 ft. high in accordance with the *Methods of Fire Tests of Building Construction and Materials* (ASTM E119). Each test wall is exposed on one face to a furnace having a fire of controlled extent and severity. The furnace temperature rises rapidly to 1700 deg. F. in one hour, and then more gradually to 2000 deg. F. in the case of a four-



A concrete masonry wall undergoing a fire test. A gas-fired furnace is on the opposite side of the wall. Hydraulic jacks under the wall impose a load of 80 psi on the wall during fire test. Every phase of the test is closely observed and recorded by engineers.

TABLE 4—Estimated Fire Resistance Ratings of Walls and Partitions of Hollow Concrete Masonry*

Type of construction	Minimum equivalent thickness** in inches for ratings of			
	4 hour	3 hour	2 hour	1 hour
Expanded slag or pumice	4.7	4.0	3.2	2.1
Expanded clay or shale	5.7	4.8	3.8	2.6
Limestone, cinders or unexpanded slag	5.9	5.0	4.0	2.7
Calcareous gravel	6.2	5.3	4.2	2.8
Siliceous gravel	6.7	5.7	4.5	3.0

* Table taken from National Building Code (1949) recommended by National Board of Fire Underwriters.

** Equivalent thickness is the average thickness of the solid material in the wall or partition. It may be found by taking the total volume of the wall unit, subtracting the volume of core spaces, dividing this by the area of the face of the unit. Where walls are plastered, stuccoed or faced with brick the thickness of plaster, stucco or brick may be included in determining the equivalent thickness.

Where combustible members are framed into the wall, the wall must be of such thickness or be so constructed that the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, will be not less than 93 per cent of the thickness shown in the table.

hour test. Bearing walls undergoing a fire test also carry a working load of 80 psi on the gross cross-sectional area of the wall.

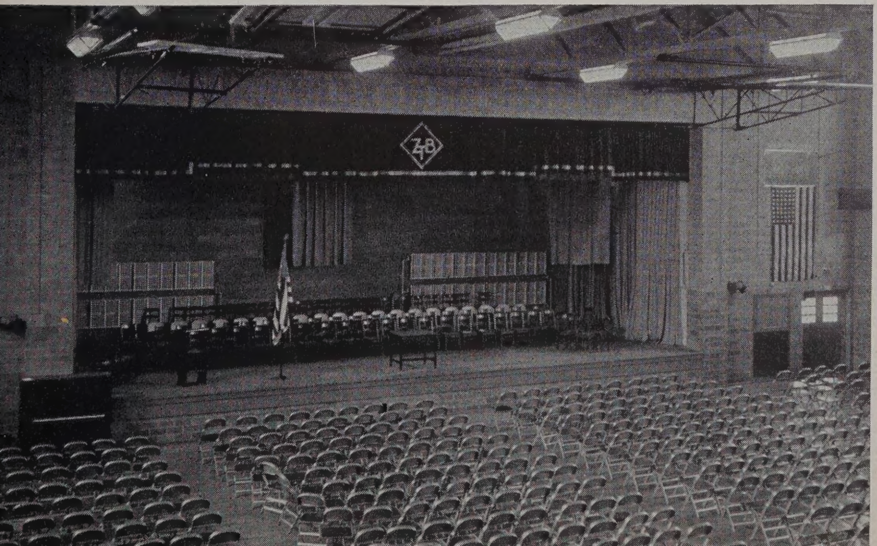
With concrete masonry walls and partitions the critical feature in determining the fire resistance rating under the fire test is usually its resistance to heat transmission measured by the rise in temperature on the unexposed surface. However, with some constructions, the critical feature may be the load-carrying ability under fire exposure or the ability to withstand the impact, eroding and cooling action of a fire hose stream applied to the hot face of the wall at the conclusion of the fire exposure.

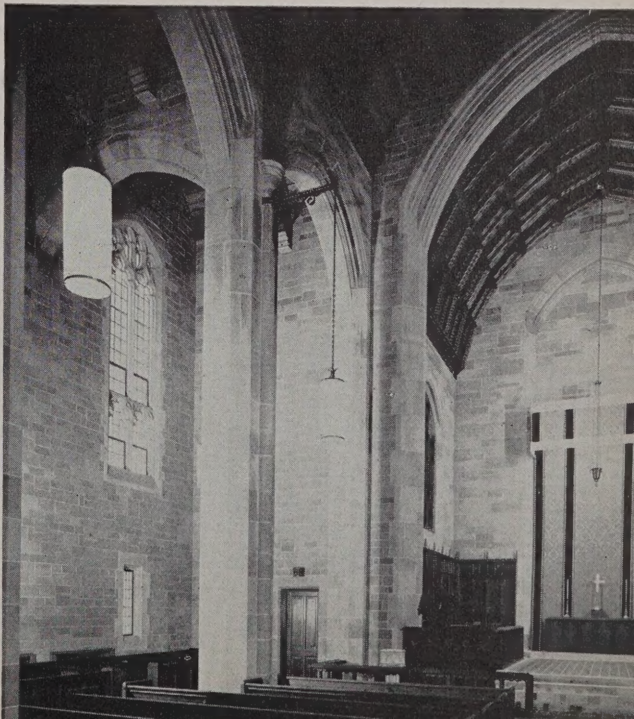
Sound Absorbing Value of Concrete Masonry

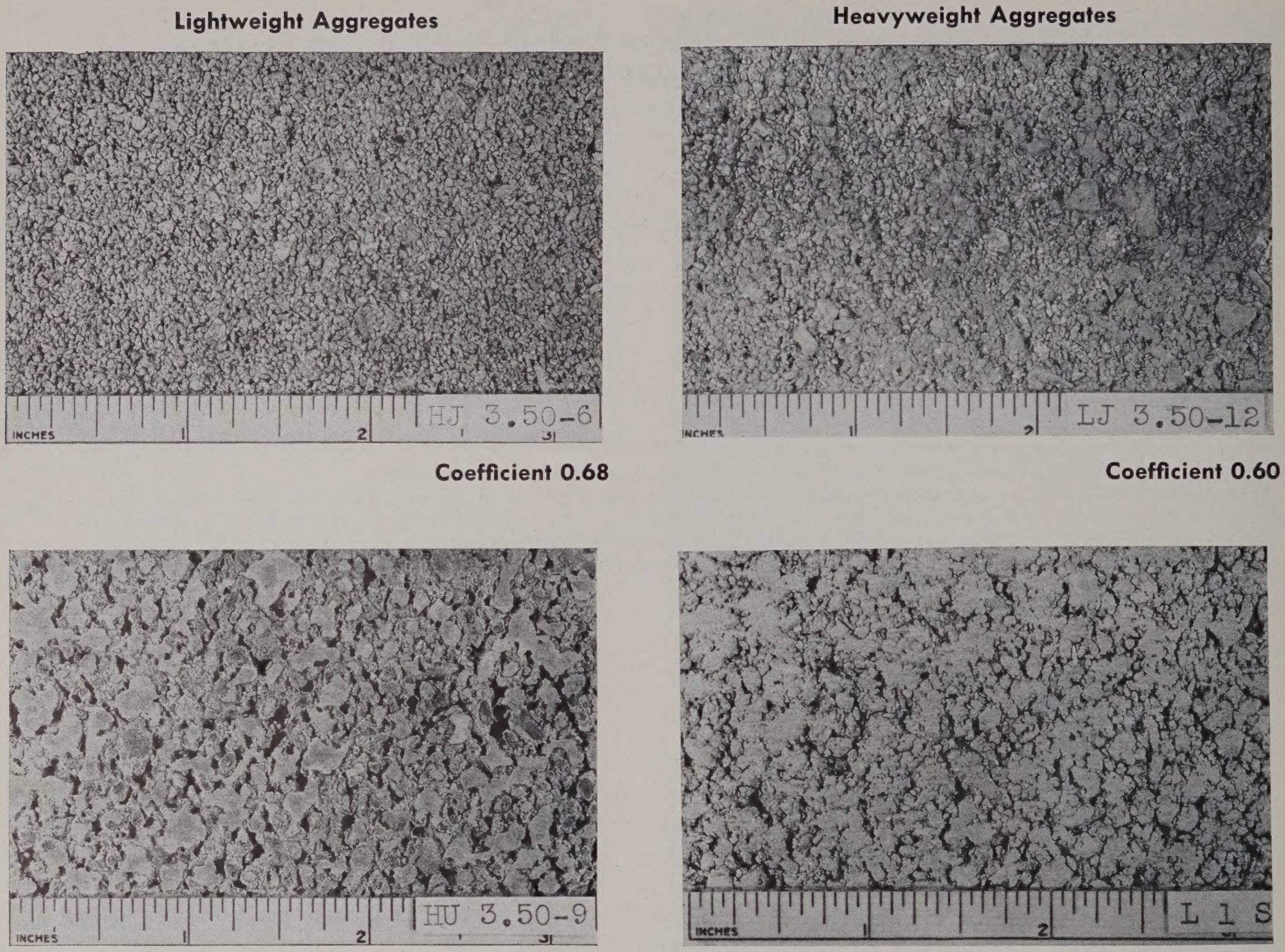
Architects and builders are devoting more attention to the reduction of noises in buildings to increase the efficiency and comfort of the occupants. Because of this trend, investigations have been made to determine the sound absorbing values of various materials. Results have indicated that concrete masonry units having open surface textures will absorb sound readily.

Sound waves upon striking a surface are partly reflected, absorbed and transmitted in varying amounts depending upon the character of the surface. A smooth

***Below*—Walls of this high school gymnasium and assembly room are faced with sound-absorbing concrete masonry. *Right*—Quietness and beauty are achieved in this church with walls of concrete masonry.**







Coefficient 0.68

Coefficient 0.60

Coefficient 0.18

Coefficient 0.21

Fig. 4—Concrete masonry units made with either lightweight or heavyweight aggregates can have similar sound absorption coefficients.

dense surface, such as hard plaster or glass, will absorb only about 3 per cent of the sound that strikes it. Exposed concrete masonry walls built with the ordinary commercial run of block will absorb between 18 and 68 per cent of the sound. Any material that will absorb 15 per cent or more is considered useful for sound control.

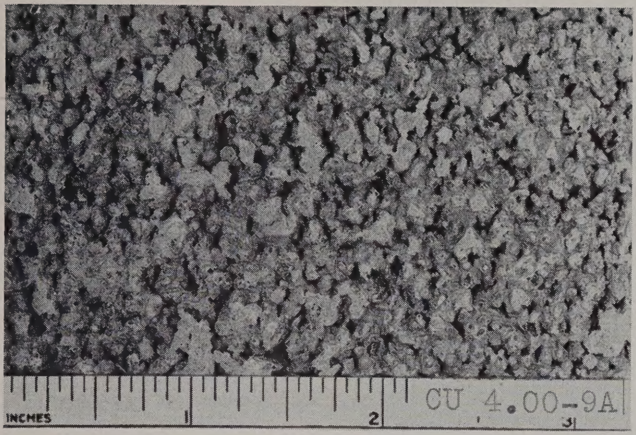
Concrete masonry made from almost any type of aggregate can have practically any kind of surface texture by careful control of the aggregate gradation, the mix, the amount of water used in the mixture and the degree of compaction at the time of molding. Fig. 4 shows that concrete masonry units made with lightweight or heavyweight aggregates can have similar surface textures with corresponding similar ranges in sound absorption values.

Fig. 5 shows how paint applied to concrete masonry tends to close the surface pores and thus reduce its value for sound control. Spray painting has less effect in closing pores of masonry than brush painting. Oil paints generally will reduce sound absorptivity more than cement base paints.

Sound Transmission Through Concrete Masonry Walls

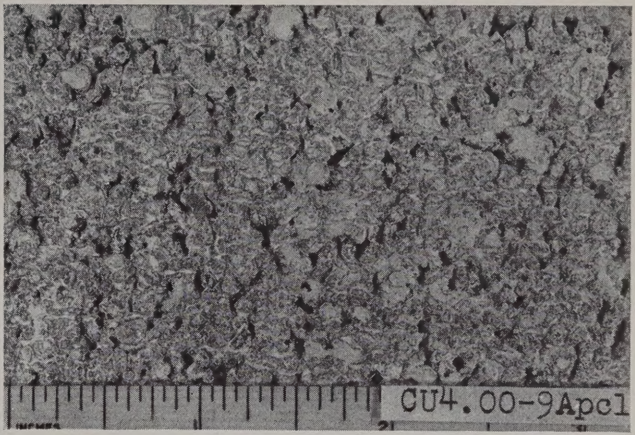
The demand for quiet rooms in hotels, apartment buildings, hospitals, schools and office buildings where noises from the street or from adjacent rooms would be objectionable has led to the use of construction materials that resist the transmission of sound.

Unpainted

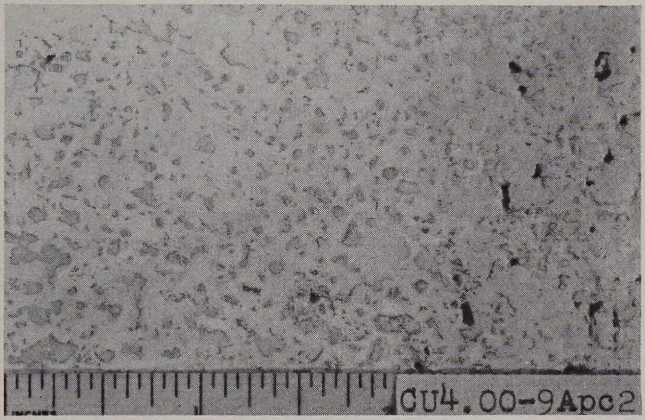

INCHES
1
2
3
CU 4.00-9A

Coefficient 0.39

One coat of portland cement paint


INCHES
1
2
CU4.00-9Apc1

Coefficient 0.22

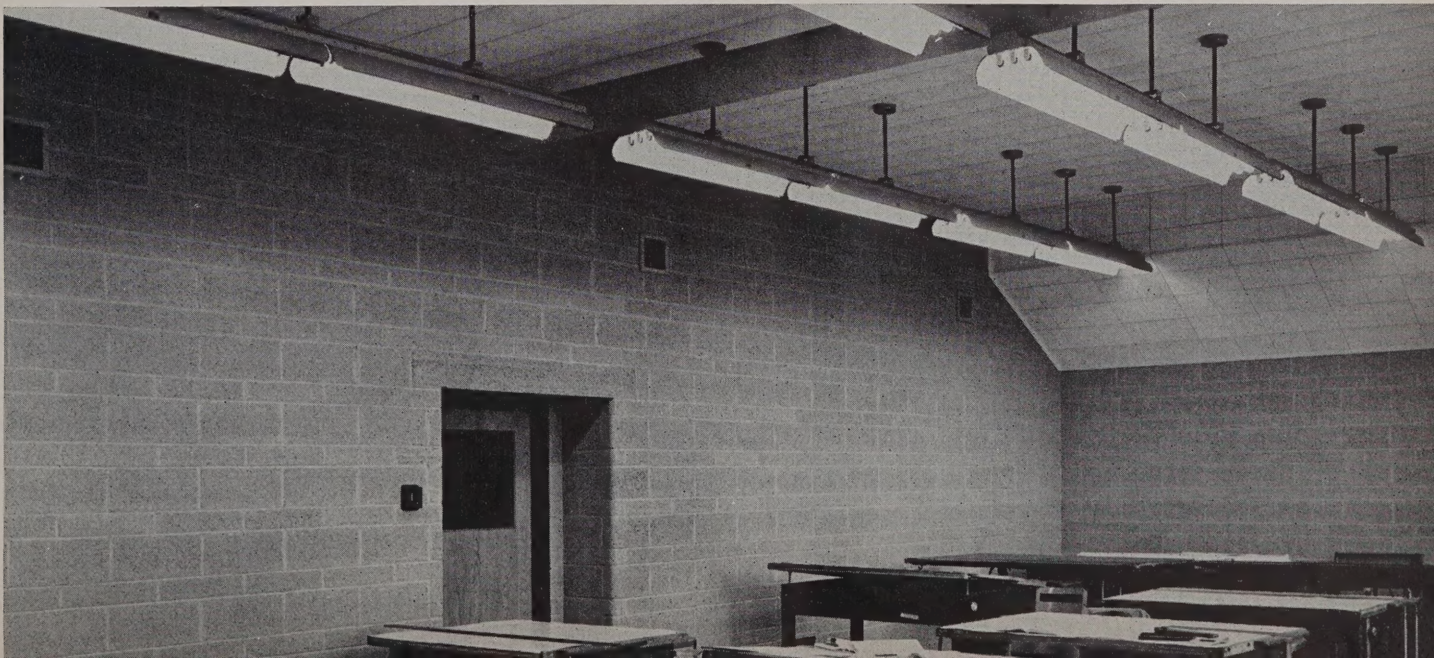

INCHES
1
CU4.00-9Apc2

Two coats of portland cement paint

Coefficient 0.19

Fig. 5—Application of paint tends to close the surface pores of concrete masonry thereby reducing the sound absorption coefficient value of the masonry surface.

Concrete masonry walls provide sound absorption and resistance to sound transmission—qualities sought in modern schools.



Walls of this attractive office are constructed of exposed, sound-absorbing concrete block laid in a stacked pattern.

In Table 5 are data showing reduction in sound transmission through walls of hollow concrete masonry. Table 6 shows relation between sound transmission loss through a wall and the hearing conditions on the quiet side. The following example shows how these data can be used. Assume that it is necessary to provide a hearing condition in a room whereby loud speech in an adjoining room cannot be understood although it can be heard faintly. Table 6 indicates that a wall having a sound reduction factor of 40 to 45 decibels will be required. Table 5 indicates that several types of walls have these or higher reduction factors.

TABLE 5—Reduction Factors in Sound Transmission Through Walls of Hollow Concrete Masonry

Walls of hollow concrete masonry	Weight per sq.ft. of wall area, lb.	Average reduction factor, decibels
3″ Cinder, ⅝″ plaster on both sides[a]	32.2	45.1
4″ Cinder, ⅝″ plaster on both sides[a]	35.8	45.6
4″ Cinder, 1″ plaster[b]	32.3	47.0
8″ Expanded slag, 1″ plaster[b]	56.0	52.6
4″ Celocrete, ½″ plaster on both sides[c]	30.0	42.6
8″ Celocrete, unplastered[c]	28.6	43.7
8″ Celocrete, ½″ plaster on both sides[c]	40.0	52.9
Cavity wall, two 4″ Celocrete, ½″ plaster on one inner face[c]	45.0	57.1
3″ Haydite, unplastered[c]	—	36.0
3″ Haydite, 1″ plaster[c]	—	42.0
4″ Haydite, unplastered[c]	—	37.0
4″ Haydite, 1″ plaster[c]	—	43.0
6″ Haydite, unplastered[c]	—	44.8
6″ Haydite, 1″ plaster[c]	—	48.5
8″ Haydite, unplastered[c]	—	47.8
8″ Haydite, 1″ plaster[c]	—	50.5
12″ Haydite, unplastered[c]	—	52.0
12″ Haydite, 1″ plaster[c]	—	54.0
4″ Pumice, ½″ plaster on both sides[d]	25.3	37.4
4″ Pumice, ½″ plaster on one side only[d]	20.4	34.6
4″ Waylite, ½″ plaster on both sides[c]	31.0	50.0
8″ Waylite, ½″ plaster on both sides[c]	47.0	53.0
3″ Waylite, painted with 2 coats cement paint[c]	16.75	44.1
4″ Waylite, unpainted[c]	16.5	33.2
4″ Waylite, painted with 2 coats cement paint[c]	16.5	46.7
6″ Waylite, unpainted[c]	21.0	39.7
6″ Waylite, painted with 2 coats cement paint[c]	21.0	52.2
Cavity wall, two 3″ Waylite, ⅜″ plaster on one unexposed face[c]	17.0	56.1

[a] National Bureau of Standards Report BMS17

[b] Data reported in *Acoustics and Architecture* by Paul E. Sabine

[c] Tests conducted at Riverbank Laboratories

[d] National Bureau of Standards Supplement to Report BMS17

TABLE 6—Relation Between Sound Transmission Loss Through a Wall and Hearing Conditions on Quiet Side*

Transmission loss in decibels	Hearing condition	Rating
30 or less	Normal speech can be understood quite easily and distinctly through the wall.	Poor
30 to 35	Loud speech can be understood fairly well. Normal speech can be heard but not easily understood.	Fair
35 to 40	Loud speech can be heard, but is not easily intelligible. Normal speech can be heard only faintly, if at all.	Good
40 to 45	Loud speech can be faintly heard but not understood. Normal speech is inaudible.	Very good, recommended for dividing walls between apartments.
45 or more	Very loud sounds, such as loud singing, brass musical instruments, or a radio at full volume can be heard only faintly or not at all.	Excellent, recommended for band rooms, music practice rooms, radio and sound studios.

*This table is based on the assumption that a noise corresponding to 30 decibels is continuously present on the listening side and that noises passing through the wall are audible despite this noise level. A decibel is roughly equivalent to the smallest change in sound energy that the average ear can detect and 30 decibels corresponds approximately to the average background noise in a quiet apartment.

DESIGNING CONCRETE MASONRY WALLS

Design and construction of concrete masonry buildings must conform to applicable local building codes. In areas having no building codes the designer can be guided by the provisions of the American Standard Building Code Requirements for Masonry, A41.1-1944, prepared by the American Standards Association. A summary of the principal requirements of this code as they apply to concrete masonry is given on pages 18 to 19.

Designing Walls to Avoid Cutting Units on Job

To achieve economy in construction, concrete masonry walls should be laid out to make maximum use of full- and half-length units. This minimizes cutting and fitting of units on the job—operations which slow up construction. All dimensions such as overall length and height of wall, width and height of door and window openings and wall areas between doors, windows and corners should be planned to use full- and half-sized units which are commonly carried in stock (see Fig. 6). Full advantage of modular design for concrete masonry requires that window and door frames be of modular dimensions which fit modular full- and half-size units. All horizontal dimensions will then be in multiples of nominal half-length units, and all vertical dimensions will be multiples of nominal full-height units. Thus, with the nominal 8x8x16-in. block, both horizontal and vertical dimensions should be designed to be in multiples of 8 in. In those sections of the country where units nominally 8 in. wide, 4 in. high and 16 in. long are used, the horizontal dimensions should be planned to be in multiples of 8 in. (half-length units) and the vertical dimensions in multiples of 4 in. Where the thickness of the wall is greater or less than the length of a half unit, a special length unit is required at each corner in each course (see drawings on page 59). It is recommended that the designer obtain schedules of the sizes of concrete masonry units locally available

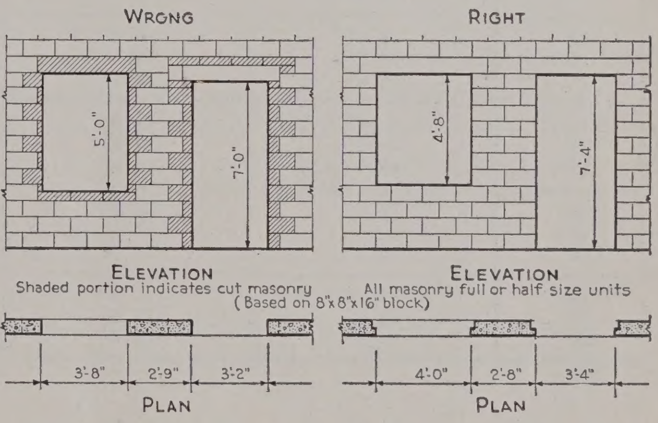
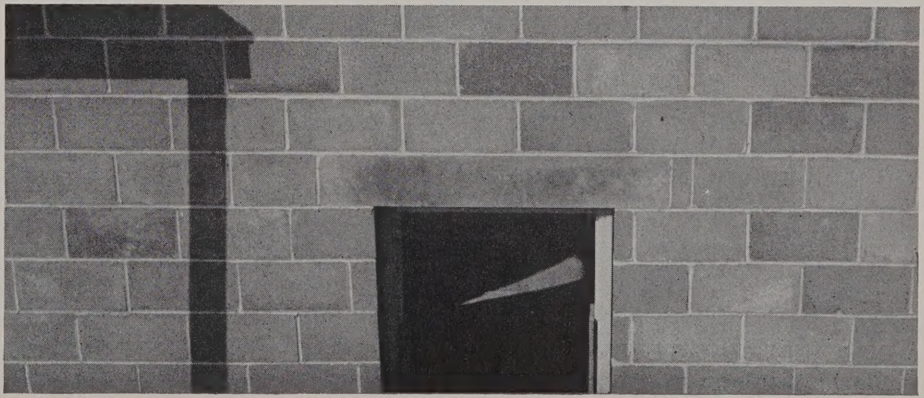

WRONG
RIGHT
5'-0"
7'-0"
4'-8"
7'-4"
ELEVATION
Shaded portion indicates cut masonry
ELEVATION
All masonry full or half size units
(Based on 8"x8"x16" block)
3'-8"
2'-9"
3'-2"
4'-0"
2'-8"
3'-4"
PLAN
PLAN

Fig. 6—Examples of wrong and right planning of concrete masonry wall openings.



An example of faulty planning. Had the door frame been moved about 4 in. to the right all cutting of masonry around door and lintel would have been eliminated.

TABLE 7—Nominal Length of Concrete Masonry Walls by Stretchers

Actual length of wall is measured from outside edge to outside edge of units and is equal to the nominal length minus ⅜″ (one mortar joint.)

No. of stretchers	Nominal length of concrete masonry walls	
	Units 15⅝″ long and half units 7⅝″ long with ⅜″ thick head joints.	Units 11⅝″ long and half units 5⅝″ long with ⅜″ thick head joints.
1	1′ 4″	1′ 0″
1½	2′ 0″	1′ 6″
2	2′ 8″	2′ 0″
2½	3′ 4″	2′ 6″
3	4′ 0″	3′ 0″
3½	4′ 8″	3′ 6″
4	5′ 4″	4′ 0″
4½	6′ 0″	4′ 6″
5	6′ 8″	5′ 0″
5½	7′ 4″	5′ 6″
6	8′ 0″	6′ 0″
6½	8′ 8″	6′ 6″
7	9′ 4″	7′ 0″
7½	10′ 0″	7′ 6″
8	10′ 8″	8′ 0″
8½	11′ 4″	8′ 6″
9	12′ 0″	9′ 0″
9½	12′ 8″	9′ 6″
10	13′ 4″	10′ 0″
10½	14′ 0″	10′ 6″
11	14′ 8″	11′ 0″
11½	15′ 4″	11′ 6″
12	16′ 0″	12′ 0″
12½	16′ 8″	12′ 6″
13	17′ 4″	13′ 0″
13½	18′ 0″	13′ 6″
14	18′ 8″	14′ 0″
14½	19′ 4″	14′ 6″
15	20′ 0″	15′ 0″
20	26′ 8″	20′ 0″

In modular planning the dimensions used on working drawings are nominal and are from center to center of mortar joints. With concrete masonry units all mortar joints are designed to be ⅜ in. thick. Fig. 7 shows how a concrete masonry wall is dimensioned on drawings while the enlarged details at the corner and jamb show how the wall is actually constructed. These enlarged details usually are not shown on plans.

Dimensioning Concrete Masonry Walls

Tables 7 and 8 show the number of full- and half-length masonry units required to obtain given dimensions. Dimensions are in accordance with modular planning. The location as well as the width and height of openings should fit these dimensions. Table 9 shows dimensions of modular openings in concrete masonry walls to accommodate various sizes of wood window frames. With metal sash it may be necessary to provide metal surrounds to fit them into modular concrete masonry openings.

TABLE 8—Nominal Height of Concrete Masonry Walls by Courses

For concrete masonry units 7⅝″ and 3⅝″ in height laid with ⅜″ mortar joints. Height is measured from center to center of mortar joints.

No. of courses	Nominal height of concrete masonry walls	
	Units 7⅝″ high and ⅜″ thick bed joint	Units 3⅝″ high and ⅜″ thick bed joint
1	8″	4″
2	1′ 4″	8″
3	2′ 0″	1′ 0″
4	2′ 8″	1′ 4″
5	3′ 4″	1′ 8″
6	4′ 0″	2′ 0″
7	4′ 8″	2′ 4″
8	5′ 4″	2′ 8″
9	6′ 0″	3′ 0″
10	6′ 8″	3′ 4″
15	10′ 0″	5′ 0″
20	13′ 4″	6′ 8″
25	16′ 8″	8′ 4″
30	20′ 0″	10′ 0″
35	23′ 4″	11′ 8″
40	26′ 8″	13′ 4″
45	30′ 0″	15′ 0″
50	33′ 4″	16′ 8″

Summary of American Standard Building Code Requirements for Masonry, A41.1-1944*

General Requirements

1. The thickness of any wall must be sufficient at all points to keep the combined stresses due to live, dead and other loads for which the building is designed, within the prescribed limits.

2. When code requirements allow for a change in wall thickness at a height which happens to come between floor levels, the greater thickness is carried up to the higher floor level.

Allowable Height and Minimum Wall Thickness

The height of a masonry wall is defined as the vertical distance to the top of the wall, including its parapet, measured from the foundation wall, girder, or other intermediate support.

(a) ***Bearing Walls.*** The allowable height and minimum wall thickness for different types of concrete masonry bearing walls based on the ASA code are shown in Table 11. Faced walls (hollow or solid concrete masonry units faced and bonded with at least 2¼-in. thickness of masonry material, such as concrete brick, clay brick, sand-lime brick, stone, terra cotta or structural clay tile) have the same allowable heights and thickness as shown for all noncavity walls.

(b) ***Nonbearing Walls.*** Allowable height and minimum wall thickness for nonbearing walls are the same as for walls shown in

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*For sale by Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.—Price 15 cents.

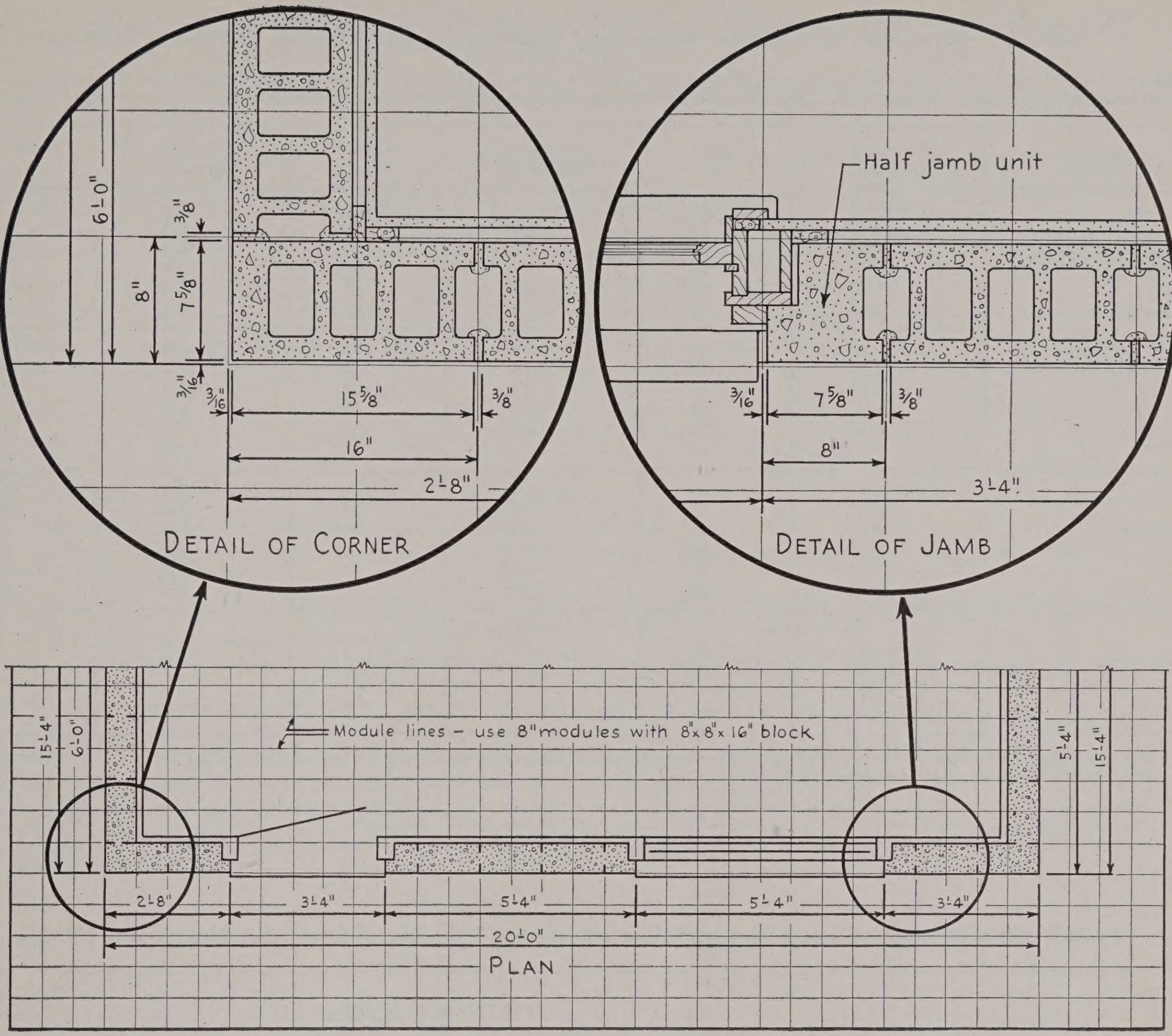


Fig. 7—Showing how concrete masonry walls are dimensioned on drawings for modular planning using nominal dimensions. Enlarged details at corner and jamb (usually not shown on drawings) show how block are actually laid in the wall.

Table 11 except that the wall thickness may be 4 in. less. Minimum thickness is nominally 8 in., except that 6-in. walls may be used for one-story single-family dwellings and one-story private garages when not more than 9 ft. in height, with an allowance of 6 ft. additional for gable.

(c) ***Nonbearing Partitions.*** Allowable height depends on thickness as indicated below. Partitions must be built solidly against floor and ceiling construction.

Unplastered thickness in.	**Maximum height ft.**
2	9*
3	12
4	15
6	20
8	25

---

*Not over 6 ft. in length.

(d) ***Parapet Walls.*** Allowable height is limited to four times the thickness unless laterally supported. In residences and in buildings in which 8-in. walls are permitted, parapets are not less than 8 in. thick; in all other buildings parapets are not less than 12 in. thick.

Lateral Supports

Concrete masonry walls must be provided with horizontal or vertical lateral supports at right angles to the face of the wall. Lateral support may be obtained by cross walls, pilasters or buttresses, when the limiting distance is measured horizontally or by floors and roofs when the limiting distance is measured vertically. The limiting distance is as follows:

(a) Walls of solid block or brick units—20 times the nominal wall thickness.

(b) Walls of hollow concrete masonry units—18 times the nominal wall thickness.

(c) Cavity walls—14 times the nominal wall thickness.

TABLE 9—Modular Concrete Masonry Openings for Wood Window Frames

Masonry openings are dimensioned from jamb to jamb and from bottom of lintel to bottom of precast concrete sill. Openings of sizes other than those shown may be used by keeping the dimensions in multiples of 8 in. Glass sizes shown are for one light but any division of the sash may be used.

Types of windows	Masonry openings	Glass size	Masonry openings	Glass size	Masonry openings	Glass size
Double	2'0"x3'4"	16"x12"	2'8"x3'4"	24"x12"	3'4"x3'4"	32"x12"
	4'0"	16"	4'0"	16"	4'0"	16"
	4'8"	20"	4'8"	20"	4'8"	20"
	5'4"	24"	5'4"	24"	5'4"	24"
	6'0"	28"	6'0"	28"	6'0"	28"
	6'8"	32"	6'8"	32"	6'8"	32"
	4'0"x4'0"	40"x16"	4'8"x4'0"	48"x16"	5'4"x4'0"	56"x16"
	4'8"	20"	4'8"	20"	4'8"	20"
	5'4"	24"	5'4"	24"	5'4"	24"
	6'0"	28"	6'0"	28"	6'0"	28"
	6'8"	32"	6'8"	32"	6'8"	32"
	7'4"	36"	7'4"	36"	7'4"	36"
Casement	1'4"x3'4"	8"x25"	2'0"x3'4"	16"x25"	2'8"x3'4"	24"x25"
	4'0"	33"	4'0"	33"	4'0"	33"
	4'8"	41"	4'8"	41"	4'8"	41"
	5'4"	49"	5'4"	49"	5'4"	49"
	6'0"	57"	6'0"	57"	6'0"	57"
	6'8"	65"	6'8"	65"	6'8"	65"
Basement	Two light sash		Three light sash			
	2'0"x2'0"	8"x12"	2'8"x2'0"	8"x12"		
	2'8"	20"	2'8"	20"		
	2'8"x2'0"	12"x12"				
	2'8"	20"				

Note: Modular masonry openings shown above should also be used for metal window frames. It may be necessary, however, to provide metal surrounds to fit the metal frames into the modular openings.

TABLE 10—Weights and Quantities of Materials for Concrete Masonry Walls

Actual unit sizes (width x height x length) in.	Nominal wall thickness in.	For 100 sq.ft. of wall				For 100 concrete units
		Number of units	Average weight of finished wall		Mortar*** cu.ft.	Mortar*** cu.ft.
			Heavyweight aggregate lb.*	Lightweight aggregate lb.**		
3⅝x3⅝x15⅝	4	225	3050	2150	4.3	1.9
5⅝x3⅝x15⅝	6	225	4550	3050	4.3	1.9
7⅝x3⅝x15⅝	8	225	5700	3700	4.3	1.9
3¾x5x11¾	4	221	3000	2150	3.7	1.7
5¾x5x11¾	6	221	4500	3050	3.7	1.7
7¾x5x11¾	8	221	5650	3700	3.7	1.7
3⅝x7⅝x15⅝	4	112.5	2850	2050	2.6	2.3
5⅝x7⅝x15⅝	6	112.5	4350	2950	2.6	2.3
7⅝x7⅝x15⅝	8	112.5	5500	3600	2.6	2.3
11⅝x7⅝x15⅝	12	112.5	7950	4900	2.6	2.3

Table based on ⅜-in. mortar joints.

*Actual weight within ±7% of average weight.

**Actual weight within ±17% of average weight.

***With face-shell mortar bedding. Mortar quantities include 10% allowance for waste.

Actual weight of 100 sq.ft. of wall can be computed by formula $W(N)+150(M)$ where:

W = actual weight of a single unit
N = number of units for 100 sq.ft. of wall
M = cu.ft. of mortar for 100 sq.ft. of wall

TABLE 11—Allowable Height and Minimum Nominal Thickness for Concrete Masonry Bearing Walls*

For buildings up to three stories in height with walls of hollow or solid concrete masonry units. For buildings over three stories, see ASA Code. (Thickness in inches)

Wall	Residential			Nonresidential			Cavity residential			Cavity nonresidential		
	one-story	two-story	three-story	one-story	two-story	three-story	one-story	two-story	three-story	one-story	two-story	three-story
3rd story	—	—	8	—	—	12 8[d]	—	—	10	—	—	12 10[f]
2nd story	—	8	8	—	12 8[d]	12	—	10	10	—	12 10[f]	12
1st story	8 6[a]	8	8	12 8[d]	12	12 16[c]	10	10	12 or 10[e]	12 10[f]	12	12[g]
Basement or foundation	12 or 8[b]			12 or 8[b]	12	12 or 16	12, 10 or 8[h] (not cavity)			12 or 10 (not cavity)		

*Based on the American Standard Building Code Requirements for Masonry (ASA A41.1-1944).

[a] May be 6 in. for one-story single-family dwellings and one-story private garages when not more than 9 ft. in height, with an allowance of 6 ft. additional for any gable.

[b] When foundation wall does not extend more than 4 ft. into the ground the wall may be 8 in. thick. With special approval of the building official this depth may be extended to 7 ft. where soil conditions warrant such an extension. In no case shall the total height of 8-in. or 10-in. concrete masonry walls, including the foundation wall, exceed 35 ft.

[c] Must be at least 16 in. if the total height of the first, second and third stories above the foundation wall, or from a girder or other intermediate supports, is more than 35 ft.

[d] Top story may be 8 in. when not more than 12 ft. in height and roof beams are horizontal and total height of masonry wall is not more than 35 ft.

[e] In no case shall total height of a 10-in. cavity wall above the foundation wall exceed 25 ft.

[f] Top story may be 10 in. when not more than 12 ft. in height and roof beams are horizontal and total height of wall is not more than 35 ft.

[g] In no case shall total height of a cavity wall exceed 35 ft. above the foundation wall, regardless of thickness.

[h] May be 8 in. for 1½-story single-family dwellings having a maximum height, including the gable, of not over 20 ft. and having nominal 10-in. cavity walls. Such 8-in. foundation walls shall be corbelled to provide a bearing the full thickness of the wall above. Total projection not to exceed 2 in. with top course a full header course not higher than the bottom of the floor joists. Individual projections in corbelling shall not be more than one-third the height of the unit.

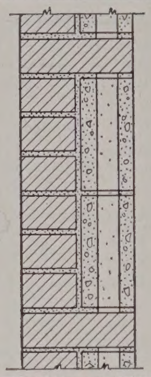
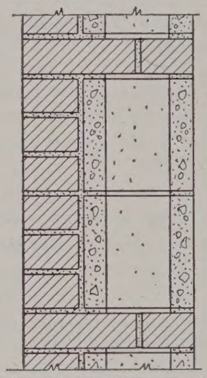
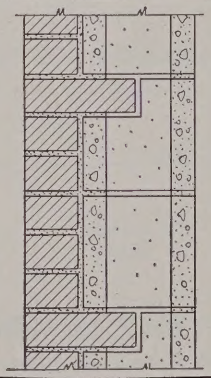
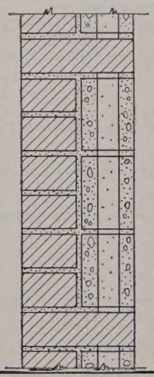
TABLE 12—Quantities of Materials Per Cubic Foot of Mortar

Mortar mixes			Quantities				Mortar produced per one sack of cement
Cement sack*	Hydrated lime or lime putty cu.ft.	Sand** cu.ft.	Masonry cement sack	Portland cement sack	Hydrated lime or lime putty cu.ft.	Sand** cu.ft.	cu.ft.
1 Masonry cement	—	3	0.33	—	—	0.99	3.0
1 Portland cement	1	6	—	0.16	0.16	0.97	6.2
1 Masonry cement *plus* 1 Portland cement	—	6	0.16	0.16	—	0.97	6.1
1 Portland cement	¼	3	—	0.29	0.07	0.86	3.5

*1 sack masonry cement or portland cement = 1 cu.ft.

**Sand in damp, loose condition.

TABLE 13—Number of Concrete Block, Brick and Mortar Required for 100 sq.ft. of Faced Wall

Number of block		Number of brick	Mortar* cu.ft.	Type of bond
Stretchers	Headers			
97 (4x8x16″)	—	772	12.2	8-in. wall  7th course bonding
97 (8x8x16″)	—	868	13.5	12-in. wall  7th course bonding
57 (8x8x16″)	57 (8x8x16″)	788	13.6	12-in. wall  6th course bonding
193 (4x5x12″)	—	770	13.1	8-in. wall  7th course bonding

*Mortar quantities based on ⅜-in. mortar joints with face-shell bedding for the block. Ten per cent included for mortar waste.

BUILDING CONCRETE MASONRY WALLS

THE TECHNIQUE of concrete masonry construction is well known to masons, builders and architects. Recommendations given in these pages conform to established modern design and construction practices.

Modular Planning Recommended

In concrete masonry as in other masonry construction it is desirable to design walls to conform to modular dimensions (see page 17). Then full advantage can be taken of full- and half-length units. A minimum of cutting and fitting of units by the mason means speedier construction and neater appearance in the finished walls.

Dry Units Essential

When delivered to the job, concrete masonry units should be dry enough to comply with the specified limitation for moisture content. They should be maintained in this dry condition by stock piling them on planks or other supports free from contact with the ground and by covering them with roofing paper or tarpaulin for protection against wetting. Moreover, at the stoppage of work at any time the top of the wall should be covered with tarpaulins or boards to prevent rain or snow from entering the cores of the block. *Concrete masonry units should never be wetted prior to laying in the wall*, a practice which is customary with some masonry materials. It is necessary to observe these precautions to lay only dry units to minimize shrinkage in the finished wall.

In some cases it may be advisable to dry block below the moisture content given in most specifications. This applies particularly where exposed concrete masonry walls are to be used in buildings where relatively high temperatures and low humidities are likely to occur over extended periods of time, as during the winter heating season. Experience has shown that damp concrete masonry units can be artificially dried to the air-dry condition which they will attain in service. This can be done by blowing heated air through the cores and the spaces between the units which are stacked to facilitate drying. Generally, this drying will not require more than 48 hours with the equipment and method described on page 8. With drying equipment having larger capacity the time can be shortened.

Footings

Footings for masonry walls should be of ample width and thickness to carry the expected loads in accordance with local building code requirements. Inadequate footings are to be avoided since they may result in uneven settlement which may cause cracking in the walls. Footings should be placed on firm, undisturbed soil of adequate load-bearing capacity and below frost penetration. In areas where there are no applicable local building codes, it is general practice to make footings for small buildings twice as wide as the thickness of the walls which will bear on them. The thickness of such footings is made equal to one-half their width (Fig. 8).

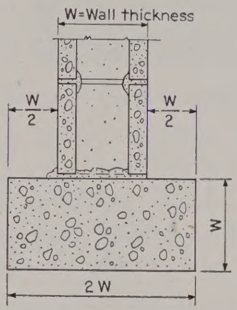
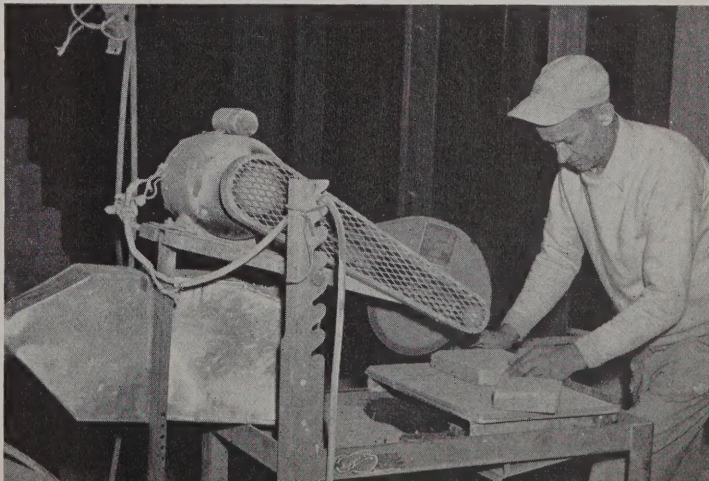
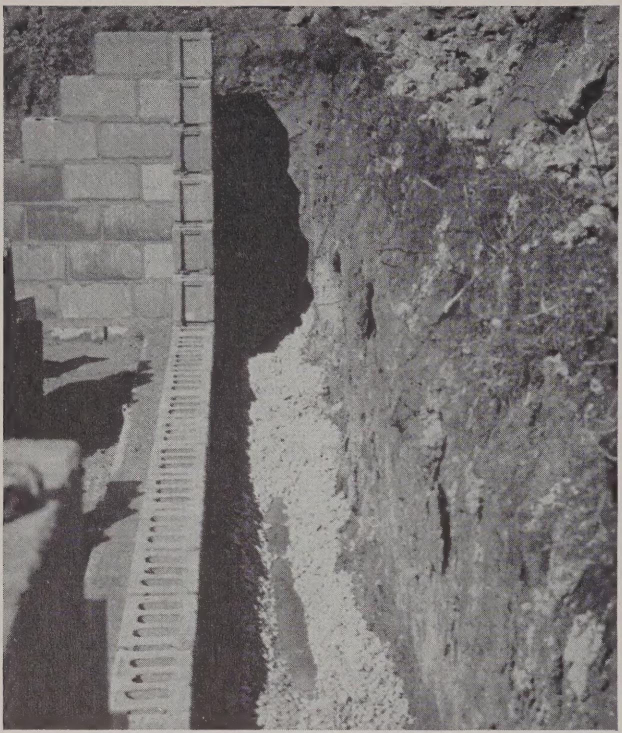


Fig. 8—Recommended footing dimensions for small buildings.

Masonry saws are used for fast, neat cutting of units to fit special job conditions. Units must be cut dry so as not to raise their moisture content.





A line of drain tile is placed around footing o help keep basement dry.

A good quality of concrete should be used for footings with not more than 7 gal. of mixing water per bag of cement, including any free moisture in the aggregate.

Subsurface Drainage

Unless the groundwater level in wet seasons is well below the footing or the basement floor, the placing of a line of drain tile along the outer side of footings is recommended. The tile line should have a fall of at least ½ in. in 12 ft. and should drain to a suitable outlet. Pieces of roofing felt placed over the joints prevent sediment from entering the tile during backfilling. The tile line should be covered to a depth of 12 in. with a permeable fill of coarse gravel or crushed stone ranging from 1 to 1½ in. in size after which the balance of the trench can be filled with earth from the excavation after the first floor is in place.

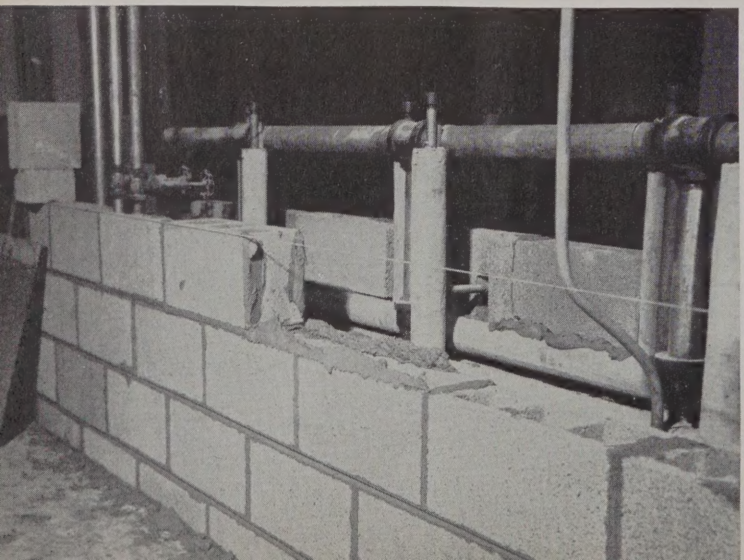
Laying Concrete Masonry

Two types of mortar bedding are common with concrete masonry—full mortar bedding and face-shell bedding. In the full mortar bedding the webs as well as the face shells are covered and bedded in mortar. It is used in laying the first or starting course of block on a footing or foundation wall. It is also commonly used in building concrete masonry columns, piers and pilasters which are intended to carry heavy loads. For all other concrete masonry work it is usual practice to use face-shell bedding.

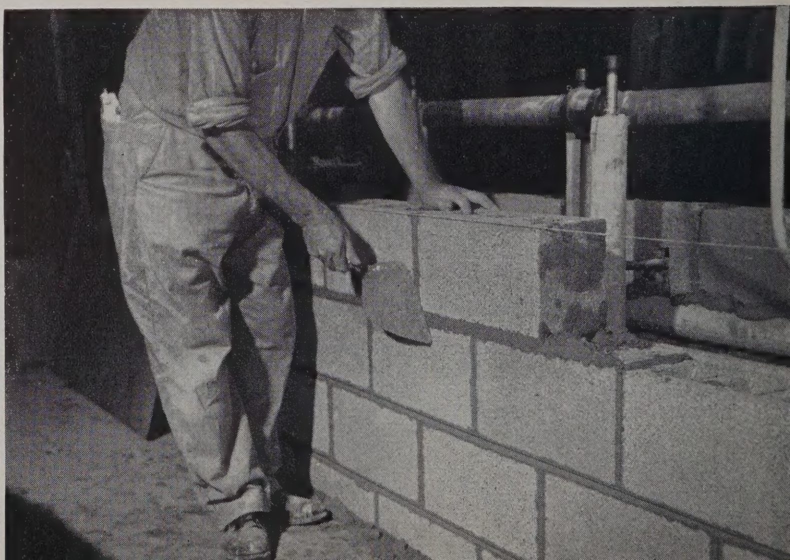
In vertical joints mortar is applied only on the face shells of the units. Some masons apply the mortar to the vertical edges of the unit previously placed. Others set the units on end and apply mortar to the vertical edges before placing them in the wall. Some masons butter both the unit laid in the wall and the unit to be set. Whatever method of buttering the vertical edges is used, each unit as placed is shoved against the block previously laid to produce well-compacted vertical mortar joints.

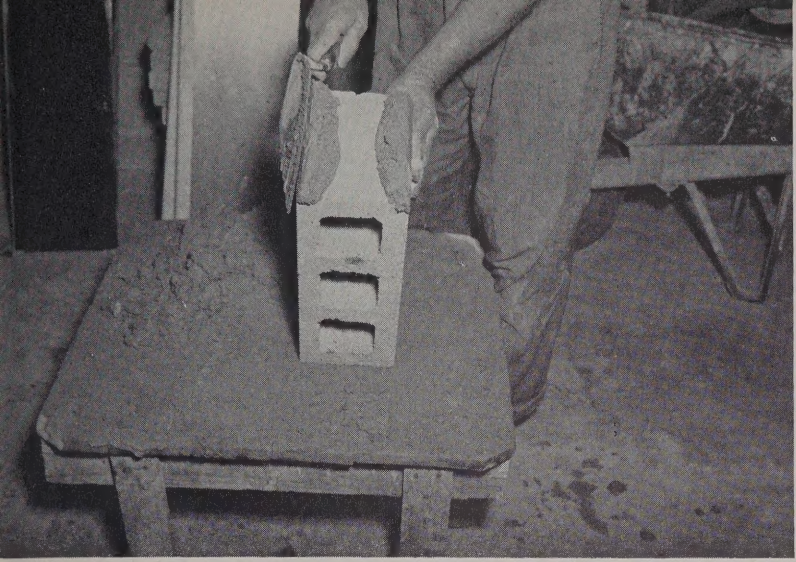
Mortar should not be spread so far ahead of actual laying of units that it will tend to stiffen and lose its plasticity, thereby resulting in poor bond. For most work

Concrete masonry is usually laid with face-shell mortar bedding.

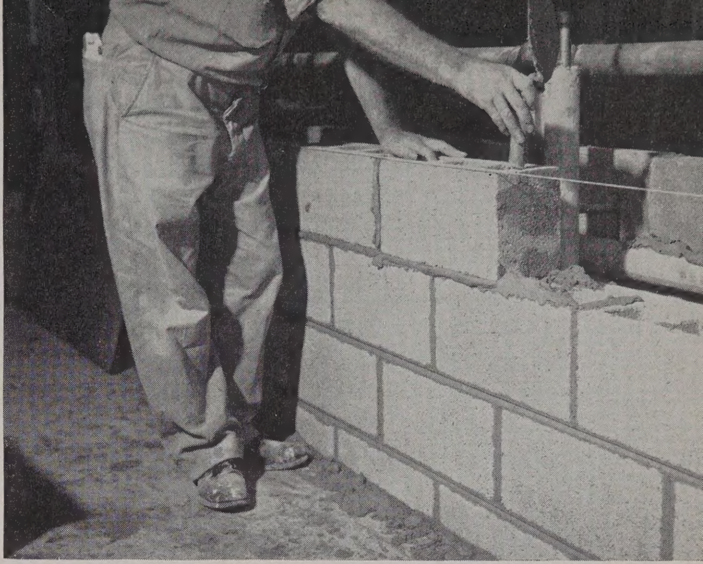


In making vertical joints some masons apply mortar to the block previously laid in the wall.





Some masons stand the block on end and apply mortar for vertical joints before laying them on the wall. (Some butter both the unit already laid and the one to be set.)



Block are laid to line and grade by following a mason's line. They are shoved tightly against previously laid masonry to insure well-compacted mortar joints.

the joints, both horizontal and vertical, should be ⅜ in. thick. Except in extruded joint construction as described on page 42 the mortar squeezed from the joints is struck off flush with the wall surface as each unit is laid. *When the mortar has stiffened somewhat,* it is firmly compacted with a jointing tool. This compaction is important since mortar, when hardening, has a tendency to shrink slightly and thus may pull away from the edges of the block. Pressing the mortar against the units with a jointing tool after the mortar has stiffened restores intimate contact between the mortar and the masonry unit and helps to make a weathertight joint. It may be necessary to add mortar, particularly to the vertical joints, to insure that they are well filled. After the joints have been tooled any excess mortar is trimmed off with the trowel.

Mortars for Concrete Masonry Walls

The cementitious materials used in mortars for concrete masonry walls should comply with current requirements of the following applicable specifications:

Masonry Cement, Federal Specifications SS-C-181b, Type II.

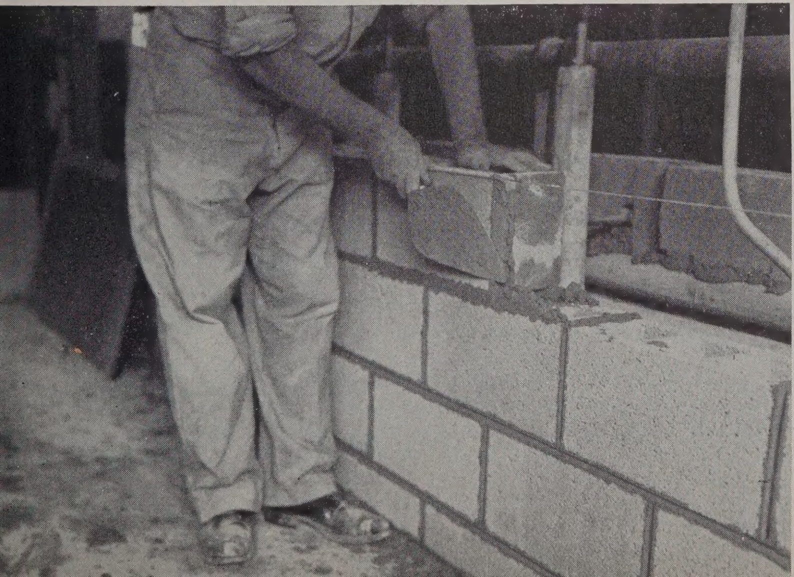
Portland Cement, ASTM C150.

Air-Entraining Portland Cement, ASTM C175.

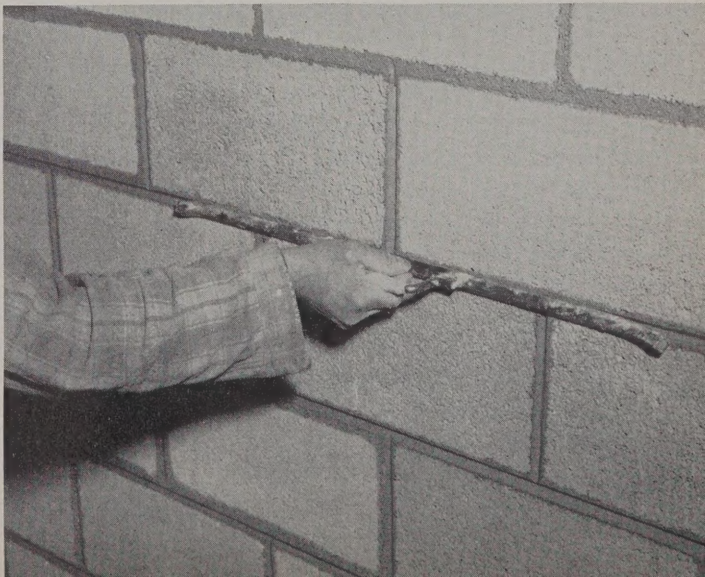
Hydraulic Hydrated Lime for Structural Purposes, ASTM C141.

Quicklime for Structural Purposes, ASTM C6.

Excess mortar squeezed out of joints is trimmed off with trowel.



Tooling of joints is important for weathertight construction.



Sand for mortar should conform to the requirements of the Specifications for Aggregate for Masonry Mortar, ASTM C144 (see Table 14). Sands deficient in fines—sizes passing the 50 and 100 mesh sieves—generally produce harsh mortars. These are difficult to handle, particularly in producing weathertight joints. On the other hand, sands finer than those permitted by the above specifications require a high mixing water content resulting in weak mortars. Addition of more cementing materials to compensate for loss in strength results in a mortar having excessive shrinkage.

Water used in mixing mortar should be clean and fit to drink.

TABLE 14—Aggregate for Masonry Mortar*

Sieve size number	Percentages passing each sieve
4	100
8	95 to 100
16	60 to 100
30	35 to 70
50	15 to 35
100	0 to 15

*ASTM C144-44.

Recommended Mortar Mixes

The volumetric proportions shown in Table 15 can be converted to weight proportions by multiplying the unit volumes by the weight per cubic foot of the materials, which may be assumed to be as follows:

Masonry cement	**Weight printed on bag**
Portland cement	**94 lb.**
Hydrated lime	**40 lb.**
Mortar sand, damp and loose	**85 lb. (approximately)**

Each mortar sand has its own characteristics, and it is difficult to specify the exact amount to be used in preparing mortars. The volumes of sand shown in Table 15 for the various mixes are generally satisfactory. However, when particularly well-graded sands are used a somewhat larger proportion of sand will be satisfactory.

Desirable Properties of Mortar

(1) ***Workability*** An important requirement of a mortar is that it be workable for the job at hand. Workability should be obtained through the proper grading of the sand and by thorough mixing rather than through the use of excessive amounts of cementitious material.

(2) ***Strength and Durability*** The strength and durability requirements of a mortar depend upon the type of service the wall is to give. Walls subjected to severe stresses or to severe weathering naturally need to be laid up in more durable, stronger mortars than walls for ordinary service. The mortar mixes listed in Table 15 provide adequate mortar strength and durability for the conditions indicated.

TABLE 15—Recommended Mortar Mixes

Proportions by Volume

Type of service	Cement	Hydrated lime or lime putty	Mortar sand in damp, loose condition
For ordinary service	1—masonry cement*	—	2 to 3
	or		
	1—portland cement	1 to 1¼	4 to 6
Subject to extremely heavy loads, violent winds, earthquakes or severe frost action. Isolated piers.	1—masonry cement* plus 1—portland cement	—	4 to 6
	or		
	1—portland cement	0 to ¼	2 to 3

*Federal Specifications SS-C-181b, Type II.

(3) ***Bond*** Bond is the property of a hardened mortar that knits the masonry units together. The strength of bond is affected by a number of factors such as kind and quantity of cementitious material, the workability of the mortar, the surface texture of the mortar bedding areas, the rate of suction of the masonry units and the quality of workmanship in making the joints.

Retempering of Mortars

After a mortar has been mixed to the required consistency and then not used for some time, it will naturally tend to stiffen. If the workability of such mortar cannot be restored by thorough re-mixing without the addition of water, the mortar should be discarded.

Antifreeze Materials

The use of an admixture to lower the freezing point of mortars during winter construction should be avoided. The quantity of such materials necessary to lower the freezing point of mortar to any appreciable degree would be so large that the mortar strength and other desirable properties would be seriously impaired.

Calcium chloride is sometimes added to a mortar mix to accelerate hardening. This shortens the time required for a mortar to attain sufficient strength to resist freezing action. Generally not more than 2 per cent of calcium chloride by weight of the portland cement should be used for this purpose. It is a safe precaution to make up small trial mixes varying the amounts of calcium chloride up to 2 per cent of the weight of the cement to determine what percentage will give the rate of hardening desired.

Repair and Tuckpointing

The mortar mixes shown in Table 15 can be used in repairing and tuckpointing old masonry walls. After the mortar has partially stiffened the joints should be thoroughly compacted by tooling.

Building Weathertight Walls

Weathertight concrete masonry walls are obtained by a combination of proper planning, the use of good materials and good workmanship.

In planning the wall, proper flashing should be provided where water, snow or ice may accumulate. Flashing is necessary at vertical joints in copings and caps, at the joints between roofs and walls and below cornices and other members projecting beyond the face of the wall. See drawing Z-220, page 55, for some flashing details.

In addition, drips should be provided for chimney caps, sills and other projecting ledges to shed water away from the wall surface. Drains and gutters must be large enough to keep water from overflowing and running down over masonry surfaces.

Good workmanship is always an important factor in building weathertight walls. Each masonry unit should be laid plumb and true, being sure that both horizontal and vertical joints are well filled and compacted by tooling when the mortar has partly stiffened.

Concave and V-shaped mortar joints (Fig. 9) are recommended for walls of exterior concrete masonry in preference to struck or raked joints that form small ledges which may hold water. With modular-size masonry units mortar joints will be approximately ⅜-in. thick. Experience has shown that this thickness of joint where properly made helps to produce a weathertight, neat, durable concrete masonry wall.

Tests made by the U.S. Bureau of Standards as described in Report BMS 95* as well as other tests** show that concrete masonry walls can be made weathertight by the application of two coats of portland cement base paint. Portland cement paint bonds well to concrete masonry and effectively seals the surface of the block as well as the mortar joints.

The application of portland cement stucco also provides a weathertight finish for concrete masonry walls.

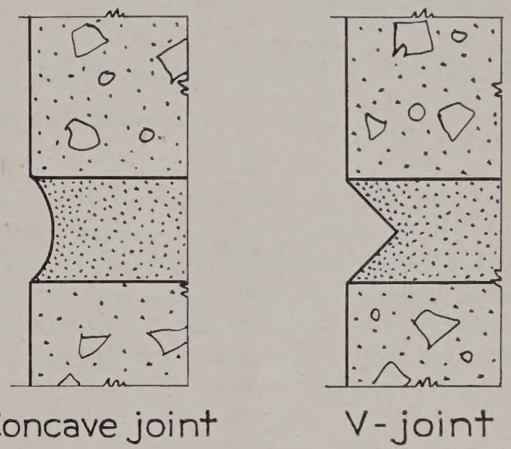


Fig. 9—Tooled mortar joints recommended for weathertight concrete masonry.

Basement Walls

Special care should be taken in building basement walls to follow the recommendations outlined under the heading, "Building Weathertight Walls." As a further assurance of dry walls, the earth side of concrete masonry basement walls should always be given two ¼-in. thick coats of plaster with the same mortar used in laying up the block (see Fig. 10). In hot, dry weather, wall surface should be very lightly dampened with a fog spray of water prior to application of first coat. First coat of plaster is roughened after it has partly hardened to provide bond for second coat. It is allowed to harden at least 24 hours before the second coat is applied. The first coat is lightly dampened just before the second coat is put on. The second coat is kept slightly damp for at least 48 hours after application.

**Tests of Cement-Water Paints and Other Waterproofings for Unit-Masonry Walls*, by Cyrus C. Fishburn and Douglas E. Parsons, issued March 15, 1943. Copies are for sale by the Superintendent of Documents. Washington, D.C.—Price 15 cents.

***Tests of the Resistance to Rain Penetration of Walls Built of Masonry and Concrete*, by R. E. Copeland and C. C. Carlson, American Concrete Institute. *Proceedings*, Vol. 36, p. 169.

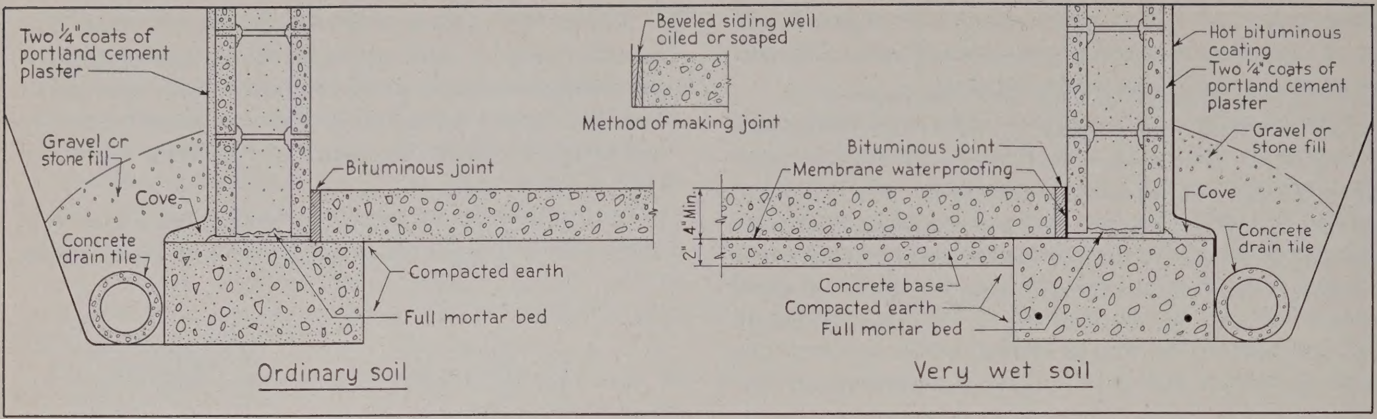
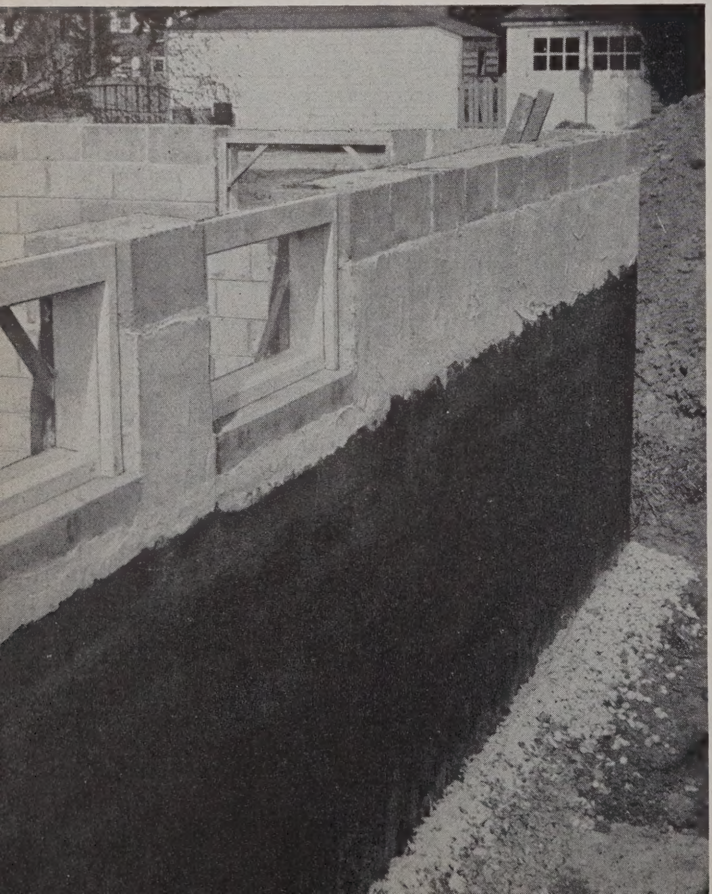
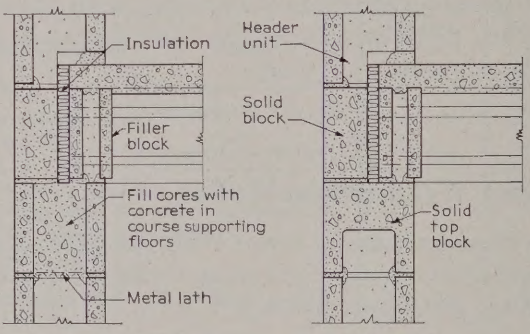

Two ¼" coats of portland cement plaster
Gravel or stone fill
Cove
Concrete drain tile
Bituminous joint
Beveled siding well oiled or soaped
Method of making joint
Compacted earth
Full mortar bed
Ordinary soil
4" Min.
2"
Bituminous joint
Membrane waterproofing
Concrete base
Compacted earth
Full mortar bed
Very wet soil
Hot bituminous coating
Two ¼" coats of portland cement plaster
Gravel or stone fill
Cove
Concrete drain tile

Fig. 10—Recommended construction for dry basements.

In very wet soils the plastered surfaces below grade are often given two continuous coatings of bituminous material brushed on over a suitable priming coat.* The second coat is applied with brush strokes at right angles to those of the first coat. The plaster must be dry when primer is applied to it and the primer coat must be dry when the bituminous material is applied.




Insulation
Filler block
Fill cores with concrete in course supporting floors
Metal lath
Header unit
Solid block
Solid top block

CORE FILLED BLOCK SOLID TOP BLOCK

Fig. 11—Methods of constructing courses supporting floors.

Supporting Floor and Roof Loads

Masonry courses which support floor beams or floor slabs should be of solid masonry. This helps to distribute the loads over the wall and provides a barrier against termites. Such courses can be constructed by filling the cores of hollow block with concrete or mortar (Fig. 11) or by using solid masonry units without cores. For filling cores a 1:2½:2½ concrete mix with all coarse aggregate passing a ½-in. screen is recommended. When local regulations permit, the cores may be filled with mortar like that used in laying the wall. Strips of expanded metal lath, laid in the bed joint below, support the concrete

In constructing dry basements it is recommended practice to apply two coats of portland cement plaster to all wall surfaces which will come in contact with the earth. Hot bituminous material is sometimes applied over plaster as added precaution for watertightness in very wet soils.

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*Coal-Tar Pitch ASTM D450-41 Type B and Creosote Primer ASTM D43-41; or Asphalt ASTM D449-47 Type B and Asphalt Primer D41-41.

or mortar filling in the cores. Cores should be completely filled. Some regulations require at least 4 in. of solid masonry for courses supporting floors or roofs. Solid top block (Fig. 1) with the top 4 in. solid are made to meet such requirements.

Attaching Plates

Plates are fastened to the wall by anchor bolts about 18 in. long, ½ in. in diameter and spaced not more than 4 ft. apart. The bolts are placed in the cores of the top two courses (Fig. 12). The cores are then filled with concrete or mortar; pieces of metal lath having been placed at the base of the cores to support the concrete mixture. After the concrete has hardened around the anchor bolts the plates are attached.

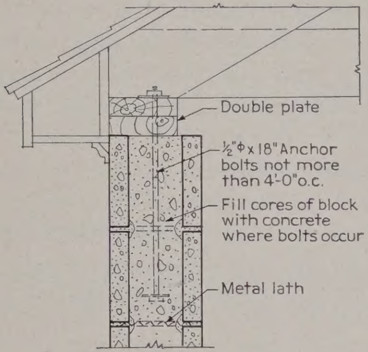

Double plate
½"Φx18" Anchor bolts not more than 4'-0" o.c.
Fill cores of block with concrete where bolts occur
Metal lath

Fig. 12—Method of fastening wood plate to top of wall.

Bonding of Meeting and Intersecting Walls

Care should be taken to securely bond or tie all walls where they meet or intersect. Following are typical requirements for such bonding:

Bearing Walls

(a) When two bearing walls meet or intersect and the courses are laid up at the same time, a true masonry bond between at least 50 per cent of the units at the intersection is necessary (see Fig. 13).

(b) When such intersecting bearing walls are laid up separately, pockets with 8-in. maximum vertical spacing are left in the first wall laid. The corresponding courses of the second wall are built into these pockets. In addition, metal anchors at least 2 ft. long (having a minimum section of ¼ in. by 1½ in. with ends bent up at least 2 in.) are placed at vertical intervals of not more than 4 ft. in the mortar joints of interlocking courses. The hooked ends of these

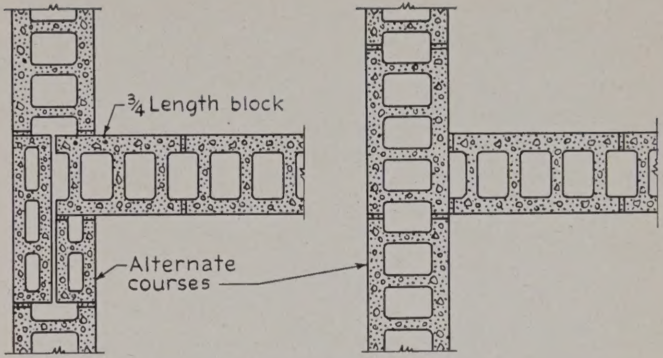
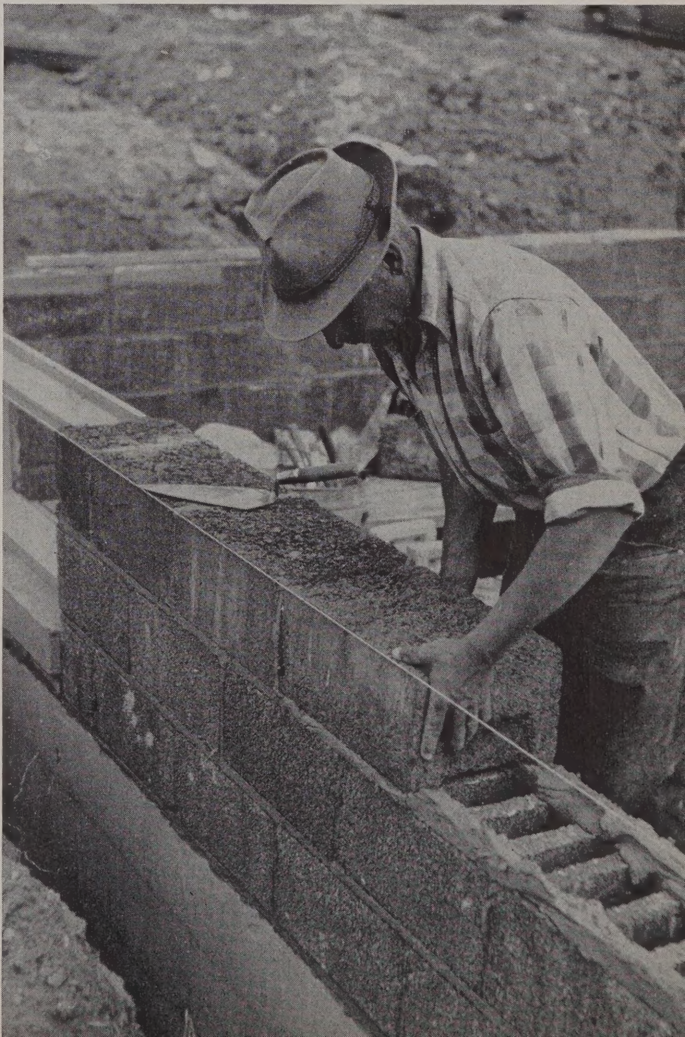
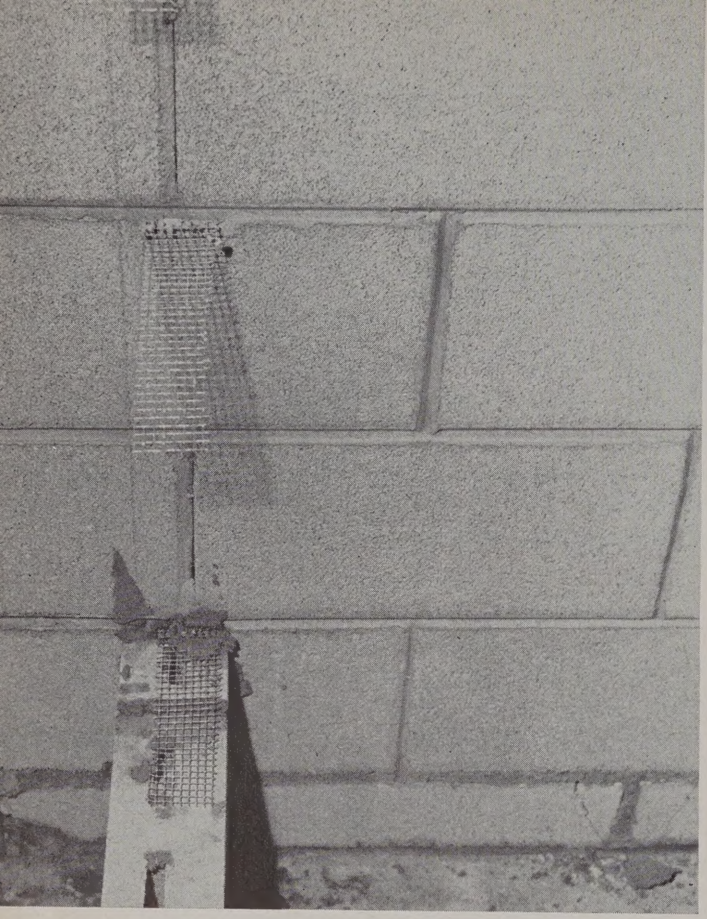


Fig. 13—Bonding of intersecting bearing walls that are laid up together.



Mason lays course of solid top block to support floors and joists. Such block are made with top 4 in. solid.



One method of bonding intersecting nonbearing walls using strips of galvanized hardware cloth in alternate courses.

anchors must engage the masonry to provide good anchorage (see Fig. 14).

Nonbearing Walls

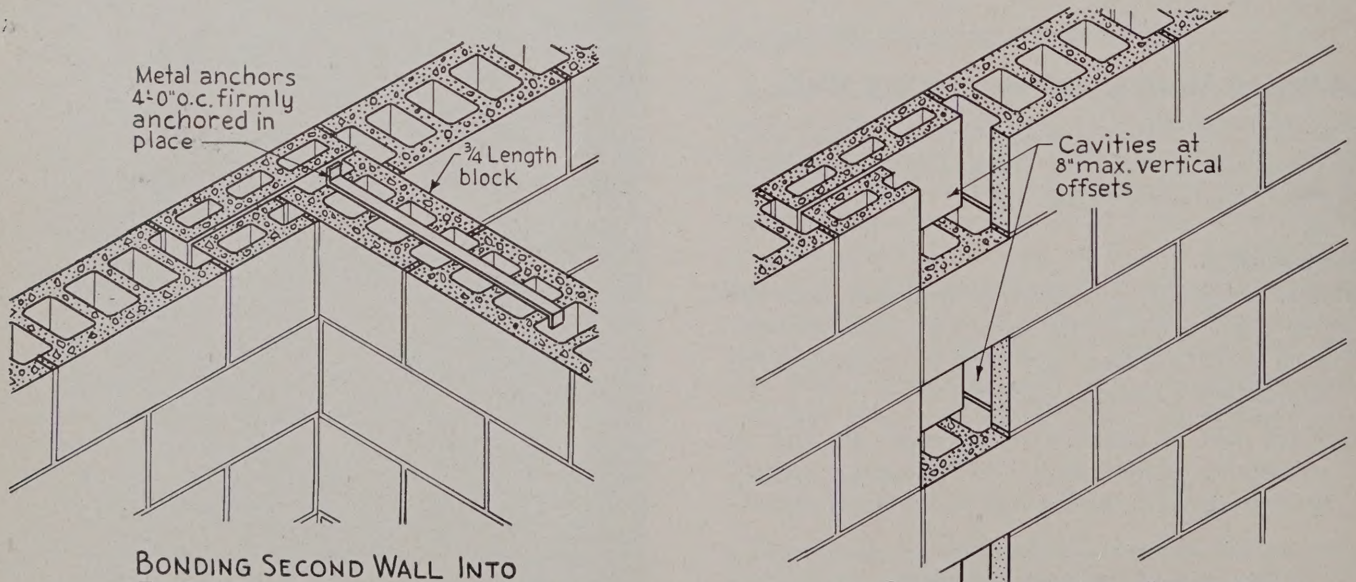
Meeting or intersecting nonbearing walls should be bonded in a manner approved by the architect. Either of the two methods recommended for bearing walls may be used.

Anchoring the Walls

Lateral support for concrete masonry walls is commonly obtained by the floors and roof. Cast-in-place concrete floor or roof slabs bearing on masonry walls are considered as providing sufficient anchorage.

When wood joists or wood beams bear on masonry walls, the ends of the joists or beams are securely anchored to the walls at maximum intervals of 6 ft. in one- and two-family dwellings and a maximum of 4 ft. in other buildings. Metal anchors at least 16 in. long having a minimum cross section of ¼ in. by 1¼ in. are fastened securely to the ends of the joists or beams and are provided with split and upset ends or other approved means for building into masonry (see drawing Z-125, page 52).

When masonry walls are parallel to wood joists or wood beams the walls must be anchored to the floor or roof joists with metal anchors spaced at maximum intervals of 8 ft. in one- and two-family dwellings and 6 ft. in other buildings. Such anchors shall engage at least

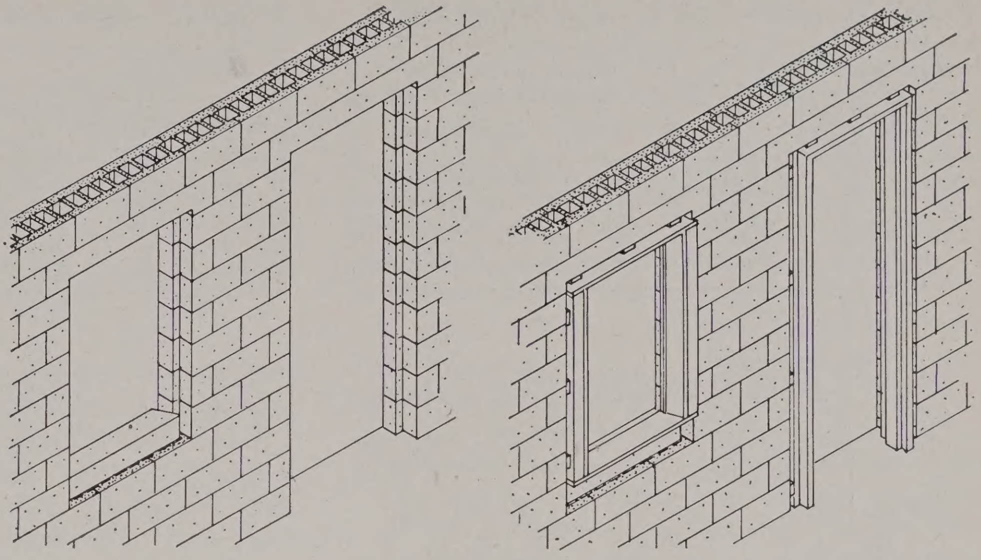

Metal anchors 4'-0"o.c. firmly anchored in place
¾ Length block
Cavities at 8" max. vertical offsets

BONDING SECOND WALL INTO FIRST WALL

CONSTRUCTION OF FIRST WALL

Fig. 14—Bonding of intersecting bearing walls that are laid up separately.

Fig. 15—Openings for windows and doors are built first—then frames are installed.


OPENINGS COMPLETED

FRAMES INSTALLED

three joists or beams and be provided with upset or T-ends which develop the full strength of the anchor strap.

Pilasters and Buttresses

For typical details of pilasters or buttresses required to carry concentrated roof or floor loads or to give lateral support to the wall, see pages 59 and 60.

Setting Door and Window Frames

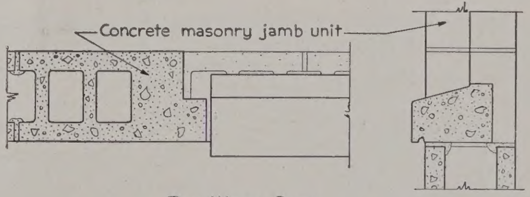
Jamb block (Fig. 1) are commonly used in laying up the sides of window and door openings. The offset design of these block and of precast concrete lintels permit window or door frames to be inserted after the walls have been laid up (Fig. 15). This method is preferred over the method of setting and bracing the frames in position on the wall and then building the walls up around them.

Sills and Lintels

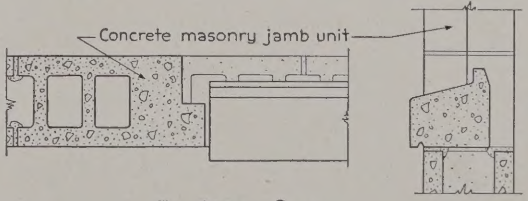
Most concrete sills are precast. However, concrete sills may be cast-in-place. Fig. 16 shows sills for use with either wood or metal window frames. The sills are sloped to drain water away quickly. A drip ledge causes the water to fall free and not run down the face and stain the wall.

Precast sills are usually installed after the masonry walls are laid. When installed as the wall is laid up they should be protected against possible breakage or staining during construction. Joints under sills should be completely filled with mortar and tightly tooled. Joints at ends of sills should be filled with mortar or with an elastic calking compound.

Lintels over door and window openings carry either the wall load or both the wall and floor loads as the design of the structure may require. Reinforced concrete lintels, one-piece or two-piece, are suitable for use. They may be precast in a products plant or can be cast-in-place.



FOR WOOD SASH



FOR METAL SASH

Fig. 16—Precast concrete sills.

TABLE 16—Lintels With Wall Load Only

Size of lintel		Clear span of lintel ft.	Bottom reinforcement	
Height in.	Width in.		No. bars	Size of bars
5¾	7⅝	Up to 7	2	⅜-in. round deformed
5¾	7⅝	7 to 8	2	⅝-in. round deformed
7⅝	7⅝	Up to 8	2	⅜-in. round deformed
7⅝	7⅝	8 to 9	2	½-in. round deformed
7⅝	7⅝	9 to 10	2	⅝-in. round deformed

TABLE 17—Split Lintels With Wall Load Only

Size of lintel		Clear span of lintel ft.	Bottom reinforcement	
Height in.	Width in.		No. bars	Size of bars
5¾	3⅝	Up to 7	1	⅜-in. round deformed
5¾	3⅝	7 to 8	1	⅝-in. round deformed
7⅝	3⅝	Up to 8	1	⅜-in. round deformed
7⅝	3⅝	8 to 9	1	½-in. round deformed
7⅝	3⅝	9 to 10	1	⅝-in. round deformed

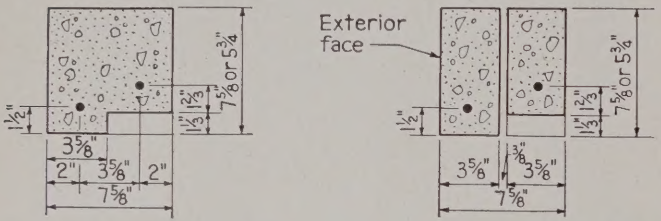


Fig. 17—One-piece lintel (see Table 16) and split lintel (see Table 17).

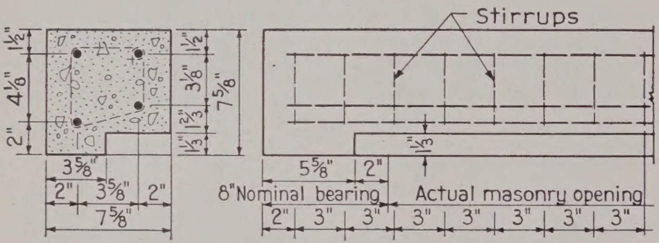


Fig. 18—One-piece lintel with stirrups (see Table 18).

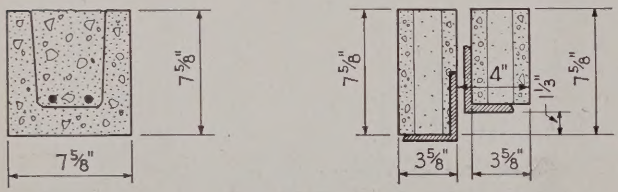


Fig. 19—Lintel block and steel angle lintels.

Fig. 17 shows one-piece and split lintels (two-piece) with accompanying Design Tables 16 and 17 for supporting wall loads only. Fig. 18 and Table 18 are for lintels supporting both wall and floor loads. Designs for lintels shown in Tables 16, 17 and 18 are based on concrete having a strength of 2000 psi. Split lintels should never be used to support combined wall and floor loads because it is difficult to design the inner section to have the same deflection as the outer section which carries wall load only. Differences in deflection of the two sections would probably result in cracks in the masonry wall. Split lintels are light in weight and easy to handle. The air space between the sections provides some insulation.

Reinforced concrete lintels should have a minimum bearing of at least 8 in. at each end. Larger bearing areas are required for lintels having long spans or carrying heavy loads. All but short simple lintels act as reinforced concrete beams and should be designed by an engineer.

Where it is desired to have lintels with a surface texture matching that of the concrete masonry wall, special cast-in-place or precast lintels are made as follows: Lintel block with depressed webs or without webs (see Fig. 1) are laid end to end forming a channel. Reinforcing rods are placed in the channel after which it is filled with concrete. If the lintel is built in place, it must be firmly supported during construction. Another method is to use steel angles to support block over openings (Fig. 19).

TABLE 18—Lintels With Wall and Floor Loads

Floor load assumed to be 85 lb. per sq.ft. with 20-ft. span

Size of lintel		Clear span of lintel ft.	Reinforcement		Web reinforcement No. 6 gage wire stirrups. Spacings from end of lintel—both ends the same
Height in.	Width in.		Top	Bottom	
7⅝	7⅝	3	None	2—½-in. round	No stirrups required
7⅝	7⅝	4	None	2—¾-in. round	3 stirrups, Sp.: 2, 3, 3 in.
7⅝	7⅝	5	2—⅜-in. round	2—⅞-in. round	5 stirrups, Sp.: 2, 3, 3, 3, 3 in.
7⅝	7⅝	6	2—½-in. round	2—⅞-in. round	6 stirrups, Sp.: 2, 3, 3, 3, 3, 3 in.
7⅝	7⅝	7	2— 1-in. round	2— 1-in. round	9 stirrups, Sp.: 2, 2, 3, 3, 3, 3, 3, 3, 3 in.

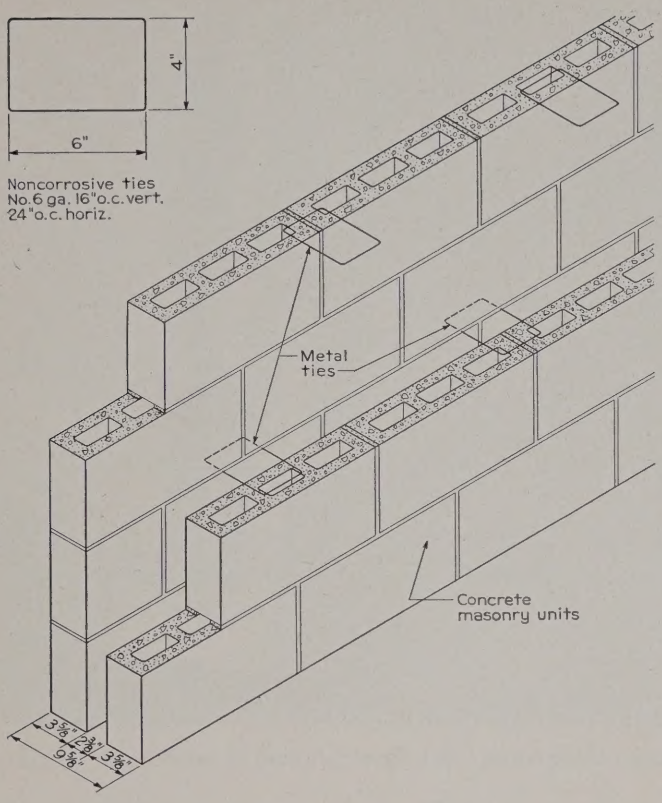


Fig. 20—10-in. cavity wall.

Cavity Wall Construction

A cavity wall consists of two walls separated by a continuous air space (Fig. 20) and securely tied together with non-corroding metal ties of adequate strength. For each 3 sq.ft. of wall surface a rectangular tie of No. 6 gage wire can be used. The ties are embedded in the horizontal joints of both walls. Additional ties are necessary at all openings, with ties spaced about 3 ft. apart around the perimeter and within 12 in. of the opening.

Typical codes require that 10-in. cavity walls should not exceed 25 ft. in height. In residential construction the overall thicknesses of concrete masonry cavity walls are nominally 10 in. or 12 in.

Neither the inner nor the outer walls should be less than 4 in. thick (nominal dimension) and the space between them should not be less than 2 in. nor more than 3 in. wide. Usually the outer wall is nominally 4 in. thick and the remaining wall thickness made up by the air space and the inner wall. For example, a modular concrete masonry cavity wall nominally 12 in. thick is composed of a 4-in. outer wall, an air space of 2 in. and a 6-in. inner wall. For further details see pages 57 and 58.

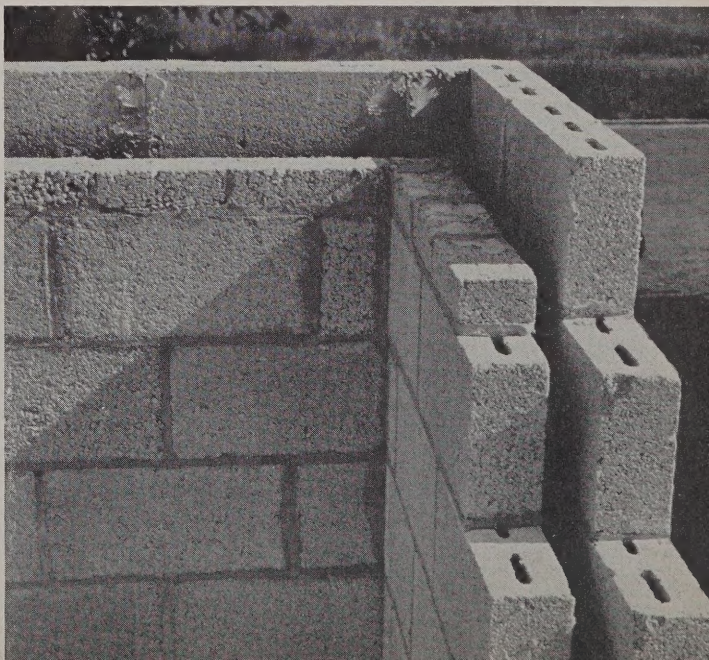
A simple method of preventing the accumulation of mortar droppings between walls and maintaining a clear cavity is to lay a 1x2-in. board across a level of ties to catch the droppings. As the masonry reaches the next level for placing ties the board is raised, cleaned and laid on the ties placed at this level.

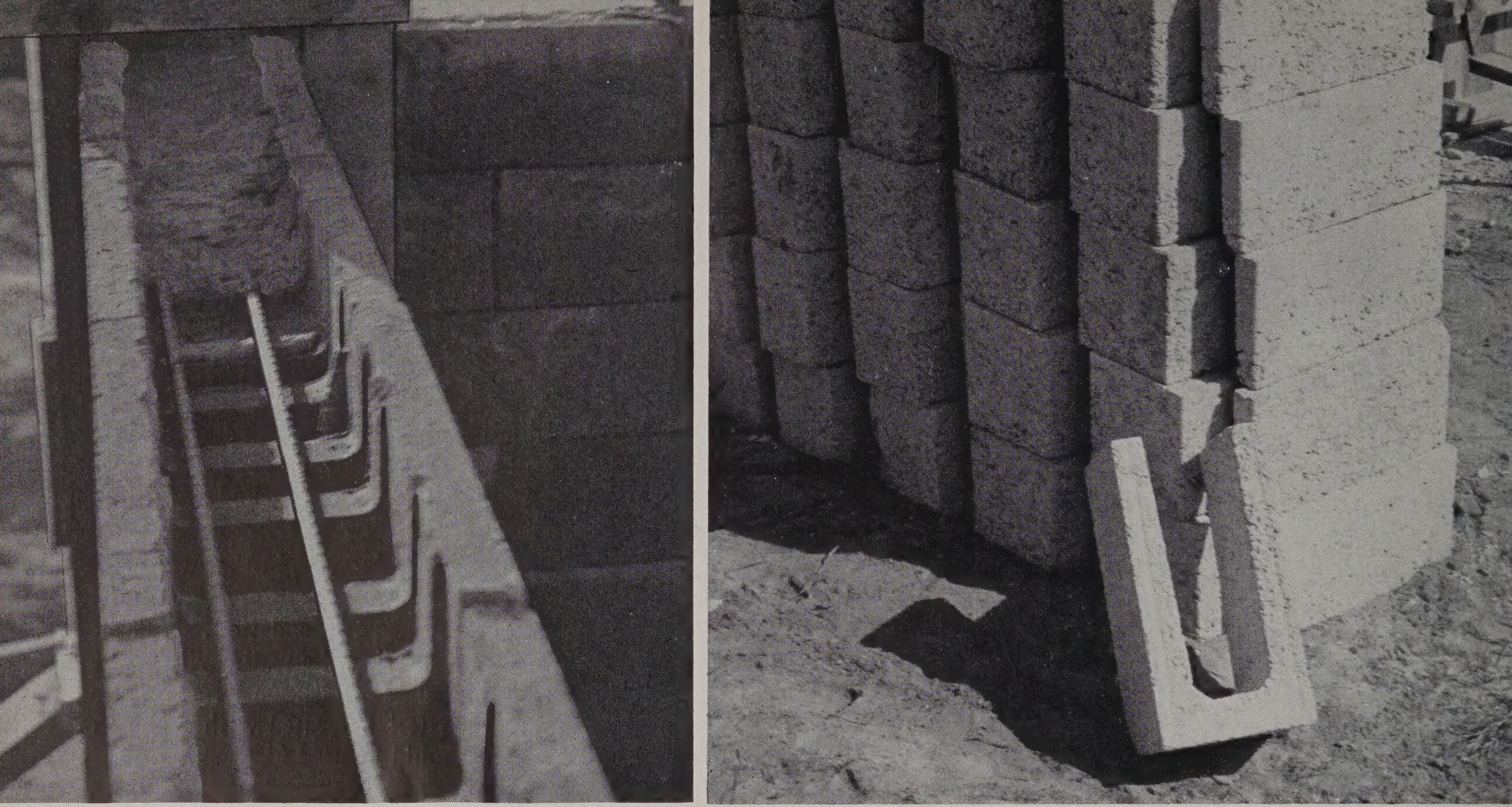
The practice of providing special flashing and weep holes in masonry cavity walls primarily presumes that water will enter the wall from the outside. If concrete masonry walls are properly designed and built with well-compacted mortar joints and are painted or stuccoed as outlined on pages 43 to 45, the walls should be weather-tight. Thus, in the great majority of cases, there should be no need for special flashing and weep holes.

However, in limited areas subjected to severe driving rains, or where experience has shown that sufficient water collects in the wall to make flashing and weep holes necessary, this practice is followed:

> The heads of windows, doors and other wall openings, and the bottom course of masonry immediately above any solid belt course or foundation, are flashed so that any moisture entering the wall cavity will be directed toward the outside walls. Only rust-resisting metal or approved materials treated with asphalt or pitch preparations should be used for flashing.
>
> Weepholes are placed every 2 or 3 units apart in the vertical joints of the bottom course of the outside wall immediately above any solid belt course or foundation. In no case should the weepholes be located below grade. Weepholes can be formed by placing well-oiled rubber tubing in the mortar joint and then extracting it after the mortar has become hard. The tubing should extend up into the cavity for several inches to provide a drainage channel through any mortar droppings that might have accumulated.

A cavity wall consists of an inner wall and an outer wall separated by an air space.





Left—A continuous reinforced concrete bond beam under construction using beam block. **Right**—A type of beam block for constructing deep bond beams.

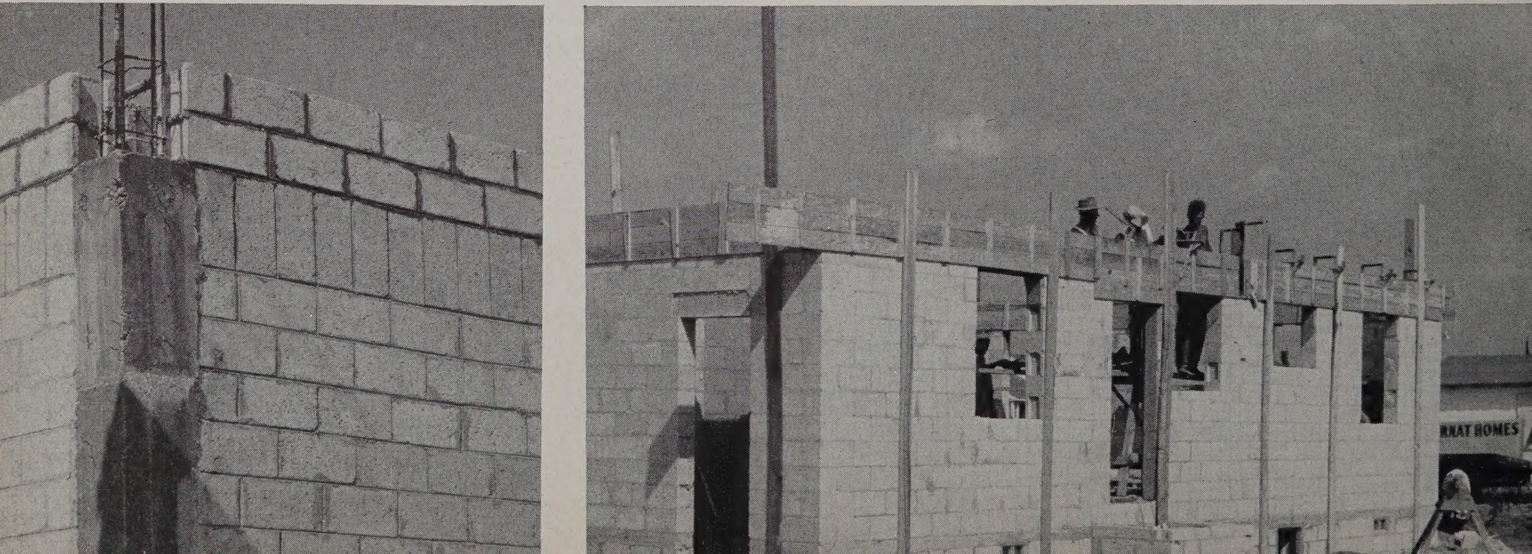
Mortar used for cavity wall construction should be composed of one of the mixes shown in Table 15 according to the type of service anticipated.

Construction of Concrete Masonry for Unusual Stress Conditions

Frequently architects and builders are confronted with local problems and requirements which need special construction techniques.

For example, in earthquake regions it is necessary to provide more than ordinary stability for all types of masonry walls. This is also true in regions where severe wind storms occur or in areas where foundation soils are unstable. Moreover, in almost any locality there are walls which are subject to excessive vibration or to very heavy loads. Often, too, there are buildings with long masonry walls which are subject to contraction and other stresses.

Left—Wall construction using deep bond beam block in third course from top of wall. The bond beam is tied into the cast-in-place reinforced concrete corner column. **Right**—Cast-in-place type of reinforced concrete bond beam.



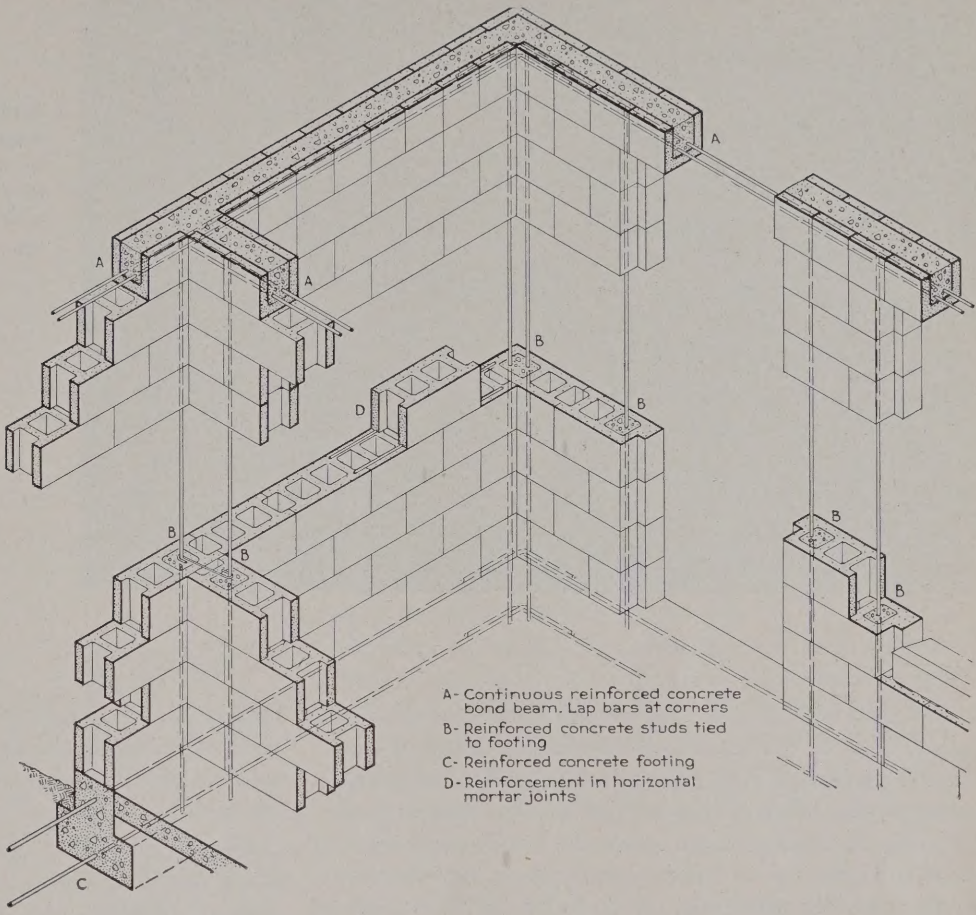
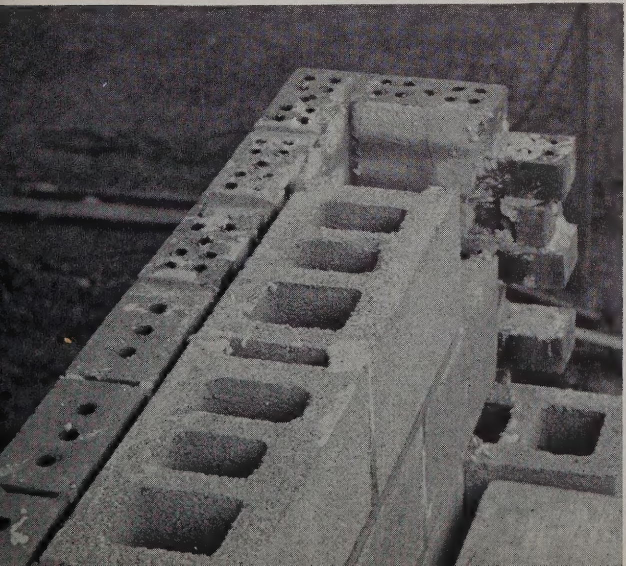

A
A
A
A
B
B
B
B
B
B
D
C
A- Continuous reinforced concrete bond beam. Lap bars at corners
B- Reinforced concrete studs tied to footing
C- Reinforced concrete footing
D- Reinforcement in horizontal mortar joints

Fig. 21—Some methods of reinforcing concrete masonry walls.

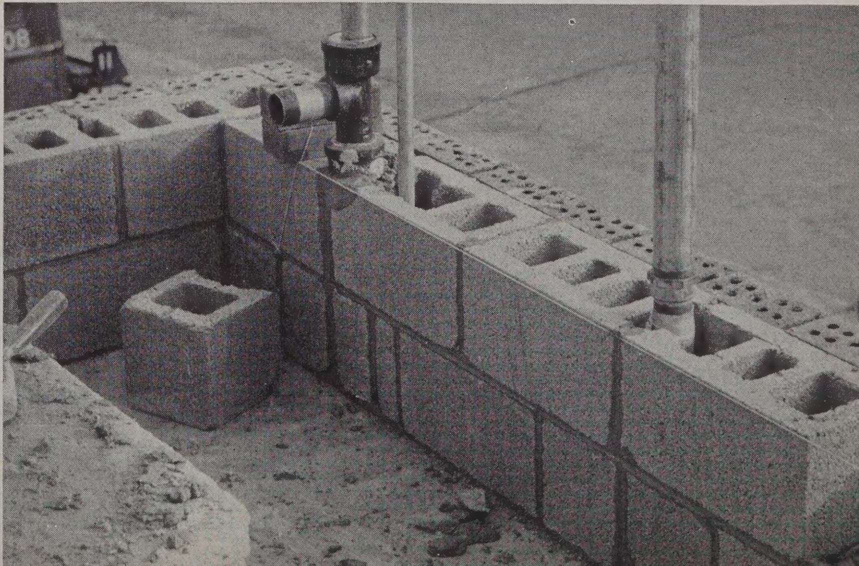
Any of these examples of unusual stress conditions require special attention by the architect and engineer and are often covered by local codes. Thus, in earthquake and hurricane regions the walls may be reinforced horizontally by continuous reinforced concrete bond beam at each story height. They also may be reinforced vertically by reinforced concrete studs at corners and at wall openings and at regular intervals between wall openings. The concrete studs are tied in with the bond beams. Size and spacing of all reinforcement is usually covered by local codes.

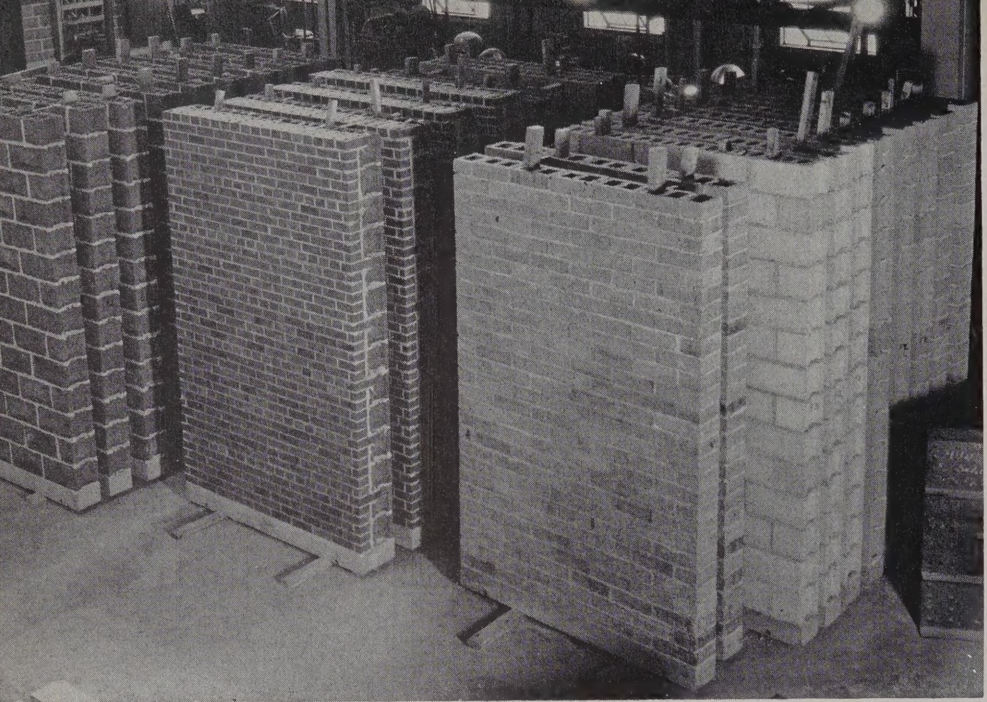
Bond beams are often constructed with special trough-

Concrete block backup for brick facing.



Plumbing and electrical conduits can be installed in concrete block backup.





Concrete masonry walls ready for tests at University of Illinois. Walls in center row are built with face brick and concrete masonry backup.

shaped beam block and the vertical alignment of the hollow cores in the units facilitates construction of the vertical studs (see Fig. 21). In other cases of unusual stress, it may be advisable to reinforce the masonry at wall openings immediately above the lintels and below the sills. Under extreme stress conditions it may be necessary to further strengthen the walls by use of continuous reinforcement placed in every second or third horizontal mortar joint (see Fig. 21).

Concrete Masonry as a Backup Material

Concrete block are meeting wide acceptance as backup for various facing materials such as brick, cut stone and cast stone. Practically any masonry facing material is used with concrete block, and when securely bonded the two materials will act together in developing high wall strength and stability.*

Furring strips can usually be nailed directly to the block or mortar joints without requiring nailing plugs, clips or other means of attachment. Special hardened nails are available for this purpose.

In building 8-in. and 12-in. walls with brick facing and concrete masonry backup, every seventh course of

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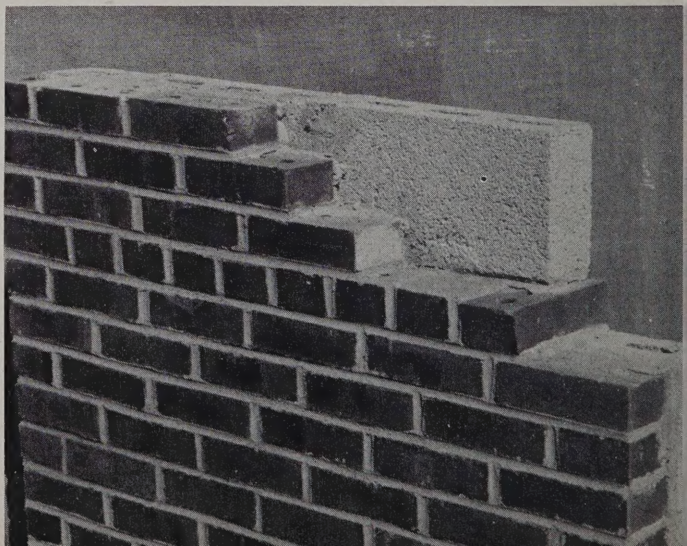
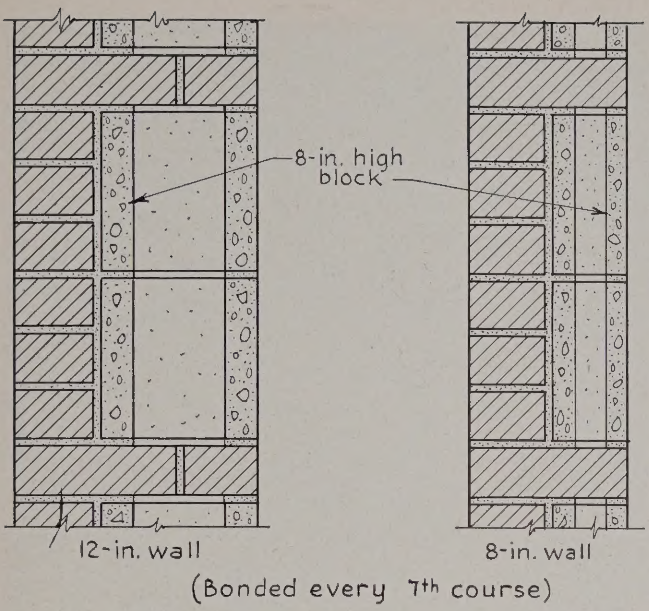
*"Strength and Stability of Concrete Masonry Walls," by F. E. Richart, R. B. B. Moorman and P. M. Woodworth, University of Illinois, *Engineering Experiment Station Bulletin*, No. 251.

Wood furring strips can be nailed directly to concrete masonry walls. Special hardened nails are often used for this purpose.

An 8-in. wall of brick facing with concrete masonry backing. Every seventh course of brick is bonded into the backing.





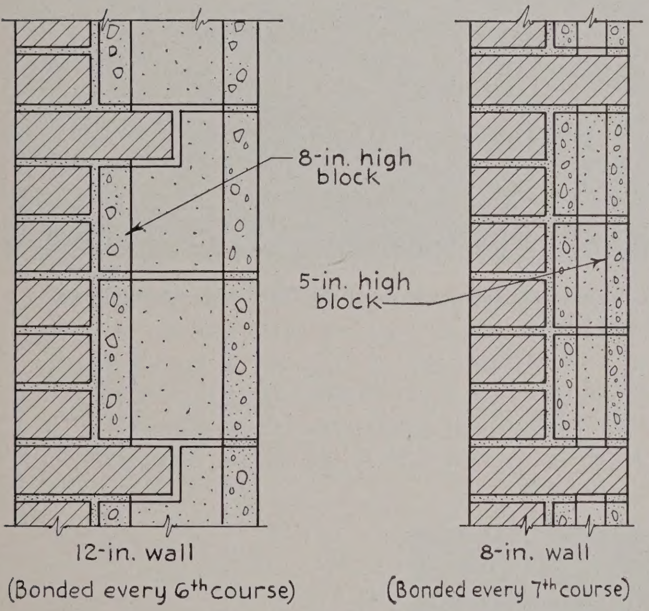


Fig. 22—Examples of concrete masonry used as backup for brick.

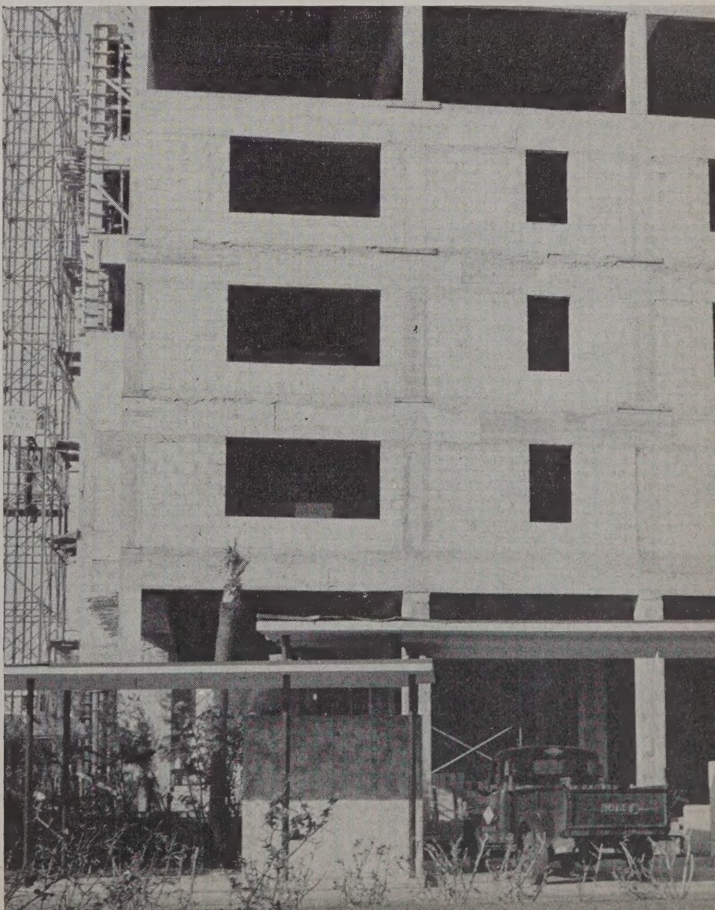
brick is a header course. The 12-in. walls can also be bonded every sixth brick course by using concrete masonry header units (see Fig. 22).

Control Joints

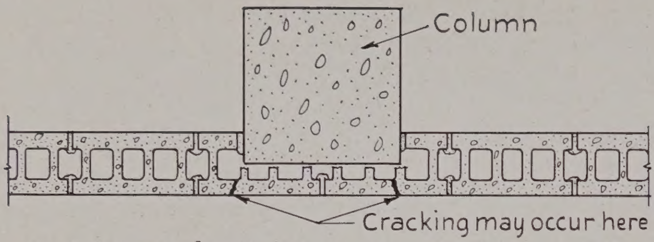
Increasing use is being made of joints to control cracking in masonry walls resulting from unusual stresses. The joints are built into the walls in such locations and in such a manner as to permit slight wall movement without cracking the masonry.

The spacing and location of these joints will depend upon a number of factors: the length of the wall, architectural details and especially on the experience records as to the need for control joints in the particular locality where the structure is to be built. Control joints may be placed at junctions of bearing and nonbearing walls, at junctions of walls and columns (Fig. 23), and pilasters, in walls weakened by chases and openings. In long walls joints are ordinarily spaced at 20- to 35-ft. intervals, again depending on local experience.

Control joints may be either of the built-in or sawed type. In the built-in type the mason leaves a clear opening between the wall sections. In the sawed type the joint is produced by a vertical saw cut shortly after the wall is laid. The depth of the saw cut should be at least equal to one-half the face shell thickness. Where walls

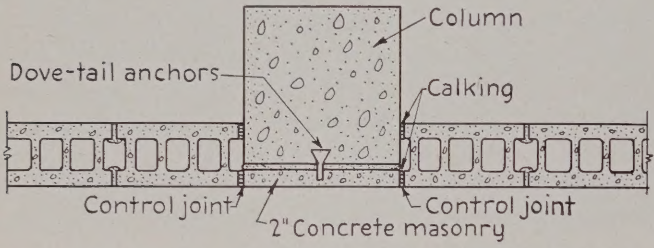


Concrete block used for panel wall construction in reinforced concrete frame structures.


Column
Cracking may occur here

Notching of units in order to preserve masonry pattern across face of column may result in cracks, as indicated, due to column restraints

WRONG


Column
Dove-tail anchors
Calking
Control joint
Control joint
2" Concrete masonry

Stresses in walls due to column restraints are minimized by control joints

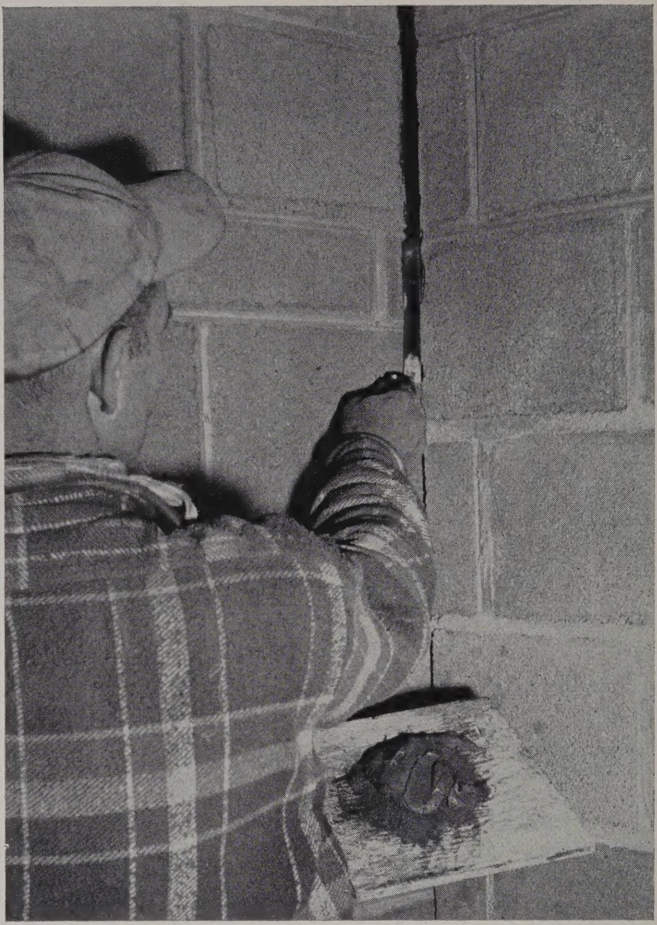
RIGHT

Fig. 23—Wrong and right methods of constructing concrete masonry walls around columns.

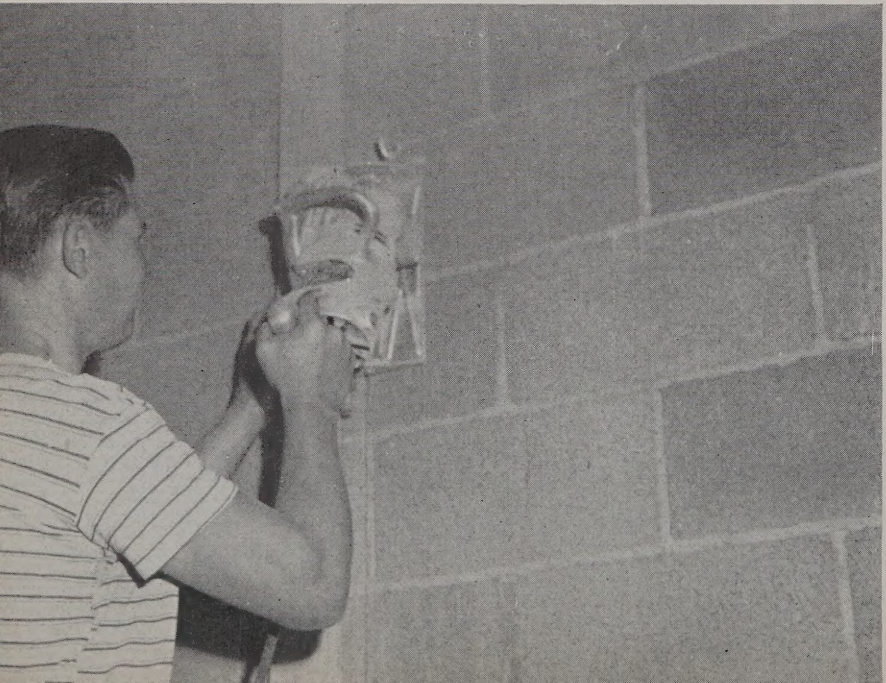
are not to be furred and plastered saw cuts should be on both sides of the wall and directly opposite each other. A masonry saw is used for this purpose.

Regardless of how the joint opening is constructed it should be filled with an elastic calking compound.

Various methods of constructing control joints are detailed on pages 59 and 60.



Control joint opening is carefully filled with an elastic calking compound.



In sawed type of control joint, vertical groove is produced by cutting with a masonry saw. A board nailed to the wall serves as a straightedge to guide the saw.

CONCRETE MASONRY WALL FINISHES

A WIDE variety of wall finishes are available with concrete masonry construction. The finish to use in any particular case will be governed by the type of structure in which the walls will be used, the climatic conditions to which the walls will be exposed, and the architectural effects desired. Several popular finishes are described in this section.

Sample Panels

Regardless of which finish is selected, it is recommended that sample panel walls be constructed on all important jobs as a means of conveying to block producers, masons and building contractors the grade of materials, quality of workmanship and precise appearance desired in the finished walls. Such panels are much more effective than written words or photographs in defining and specifying the quality of work required.

Panels should be about 40 in. long and at least four courses high and constructed of block of the same type, size, and surface texture as will be used in the finished wall. The units also should be laid in the same pattern with the same kind of joints as will be required in the finished work. If finished walls are to be painted, panels should also be painted.

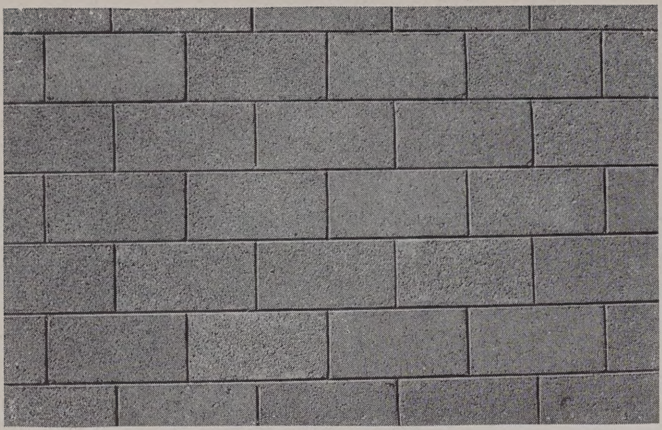
Panels should be kept for reference until the construction is completed in a satisfactory manner.

Wall Patterns and Surface Treatments

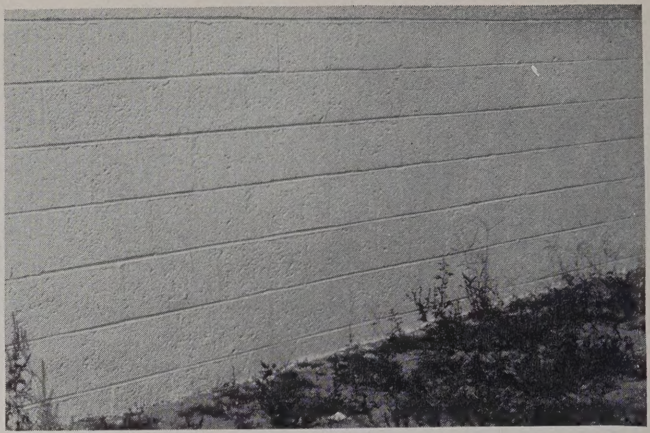
Architects have worked out many interesting variations in treatment of course heights and joints. Several popular wall patterns are illustrated on pages 40 and 41. The units may be laid in regular courses of the same height, or in courses of two or more different heights, or several sizes of units may be laid up in a prearranged ashlar pattern.

In some wall treatments all the joints are accentuated by deep tooling; in others only the horizontal joints are accentuated. In the latter treatment the vertical joints after tooling are refilled with mortar and then rubbed flush after the mortar has partially hardened to give it a texture similar to that of the concrete masonry units. In this treatment the tooled horizontal joints stand out in

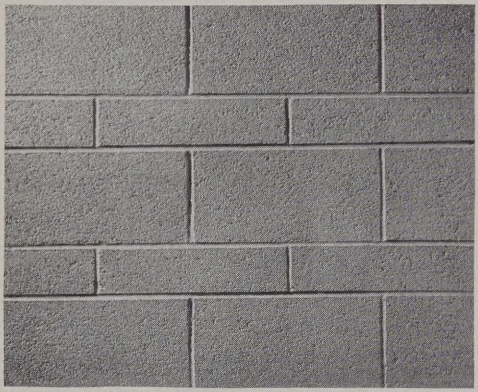
A flush vertical joint is finished by rubbing with a piece of masonry or block of wood.



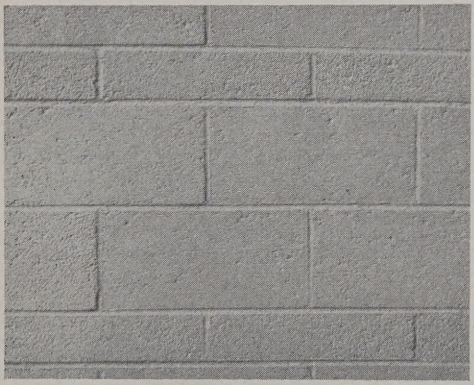
Running bond with all joints tooled.



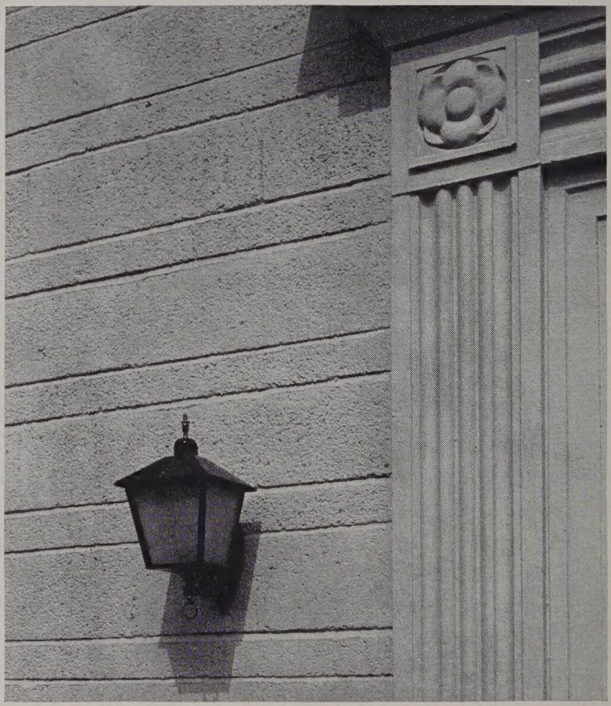
Running bond with tooled horizontal joints and rubbed vertical joints.



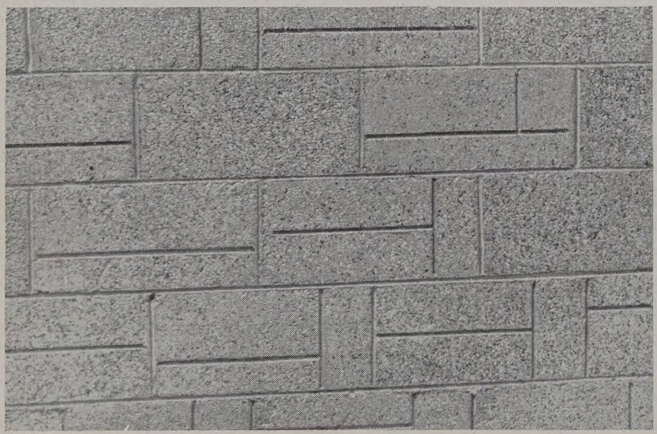
Alternate courses of 4- and 8-in.-high units. All joints tooled.



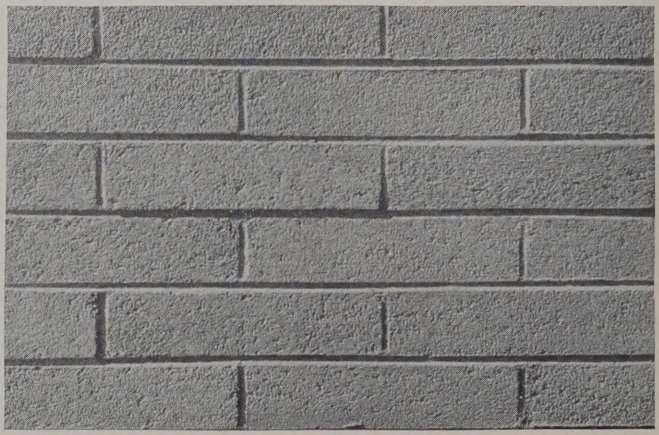
One 4-in. and two 8-in. courses with all joints tooled.



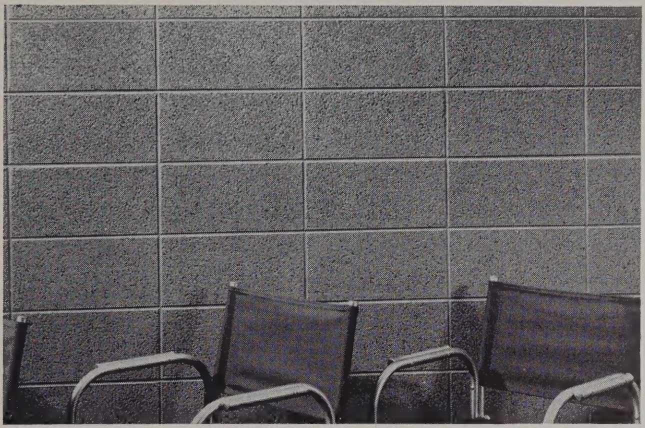
Alternate courses of 4- and 8-in.-high units. Horizontal joints tooled to accentuate horizontal lines.



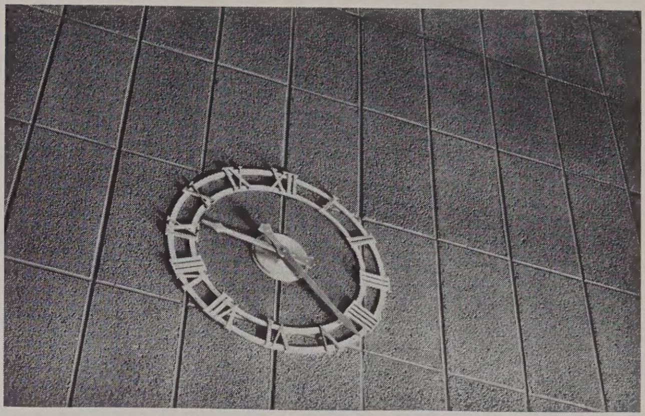
8x16-in. units scored with masonry saw to produce ashlar masonry.



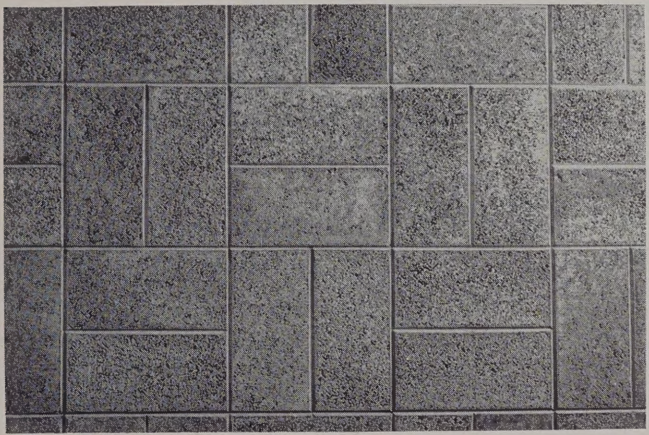
Running bond with all joints tooled.



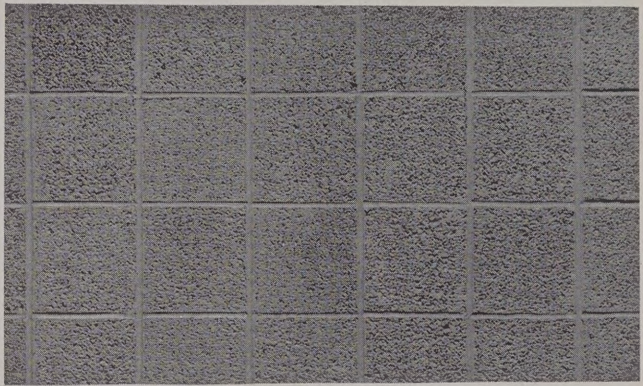
Units stacked horizontally with all joints tooled.



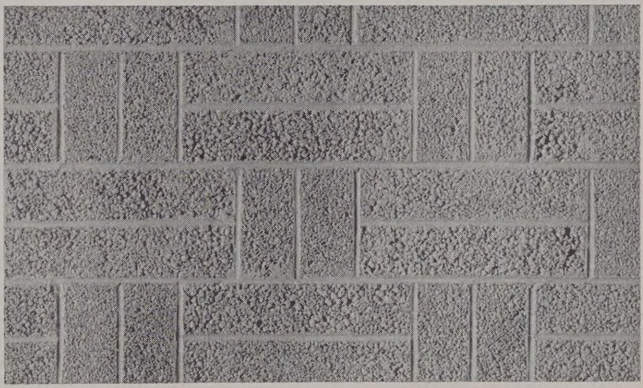
Units stacked vertically with all joints tooled.



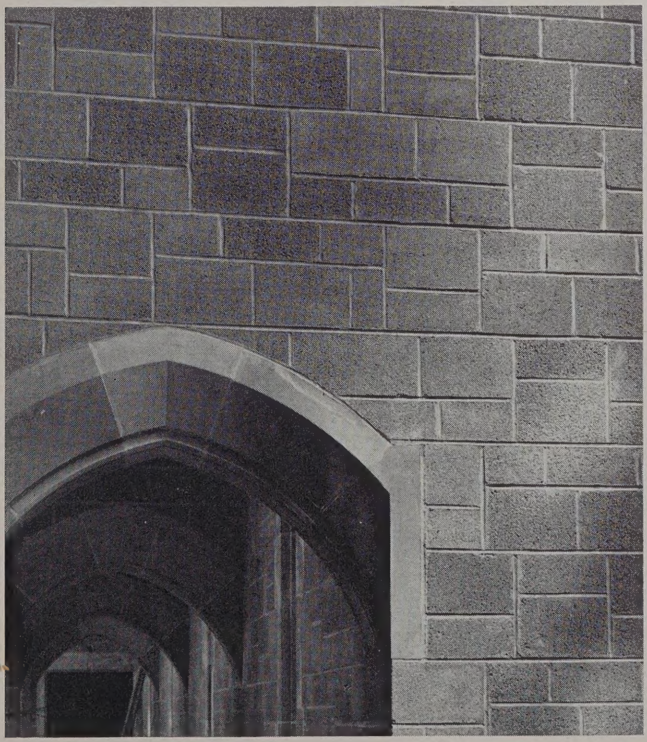
Basket weave pattern with all joints tooled.



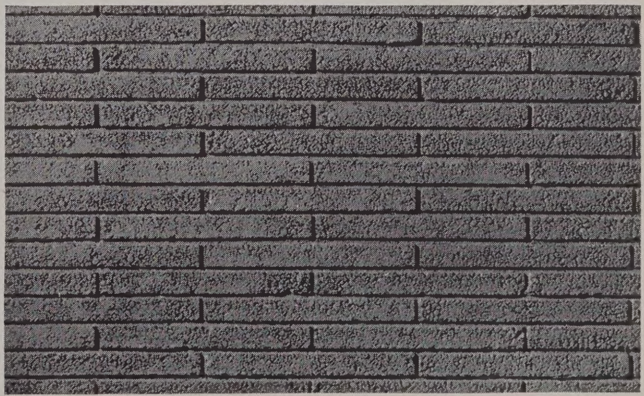
Square units stacked.



Full- and half-length units in basket weave pattern.



Coursed patterned ashlar.

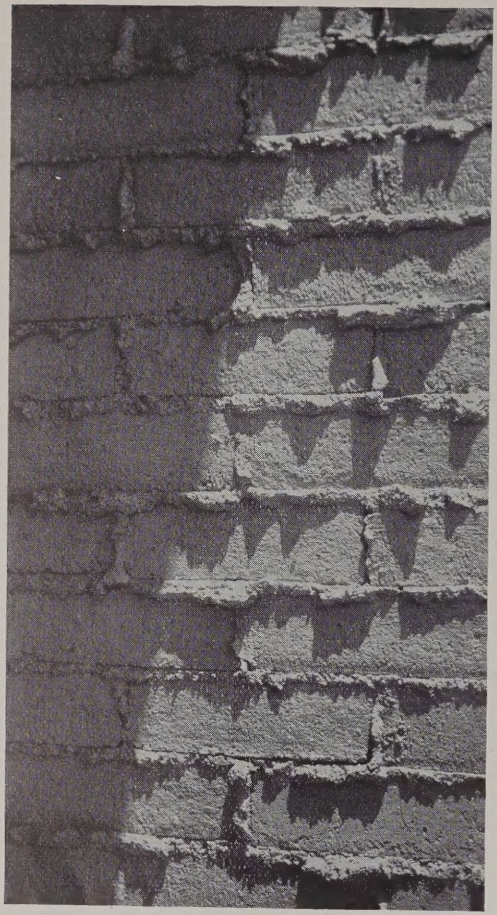


Roman concrete brick.

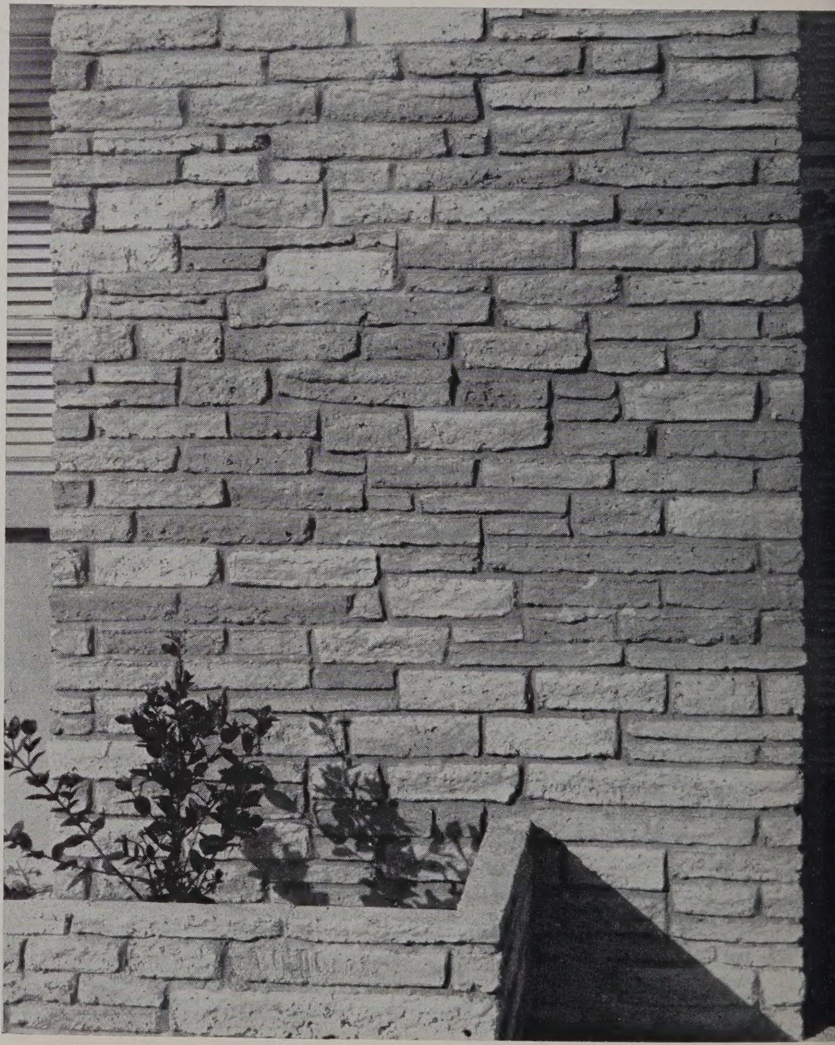
strong relief. It is well suited to buildings where it is desired to emphasize strong horizontal lines. Where an especially massive effect is sought, every second or third horizontal joint may be tooled, with all other joints, both horizontal and vertical, rubbed flush after tooling and refilling with mortar.

Another variation in finish is obtained by extruded joints. An excess of mortar is used. Some of the mortar is squeezed out or extruded as the block are set and pressed into place. This mortar is not trimmed off but is left to harden in its extruded form. This treatment is best suited to dry climates since the extruded joints may not be entirely weathertight.

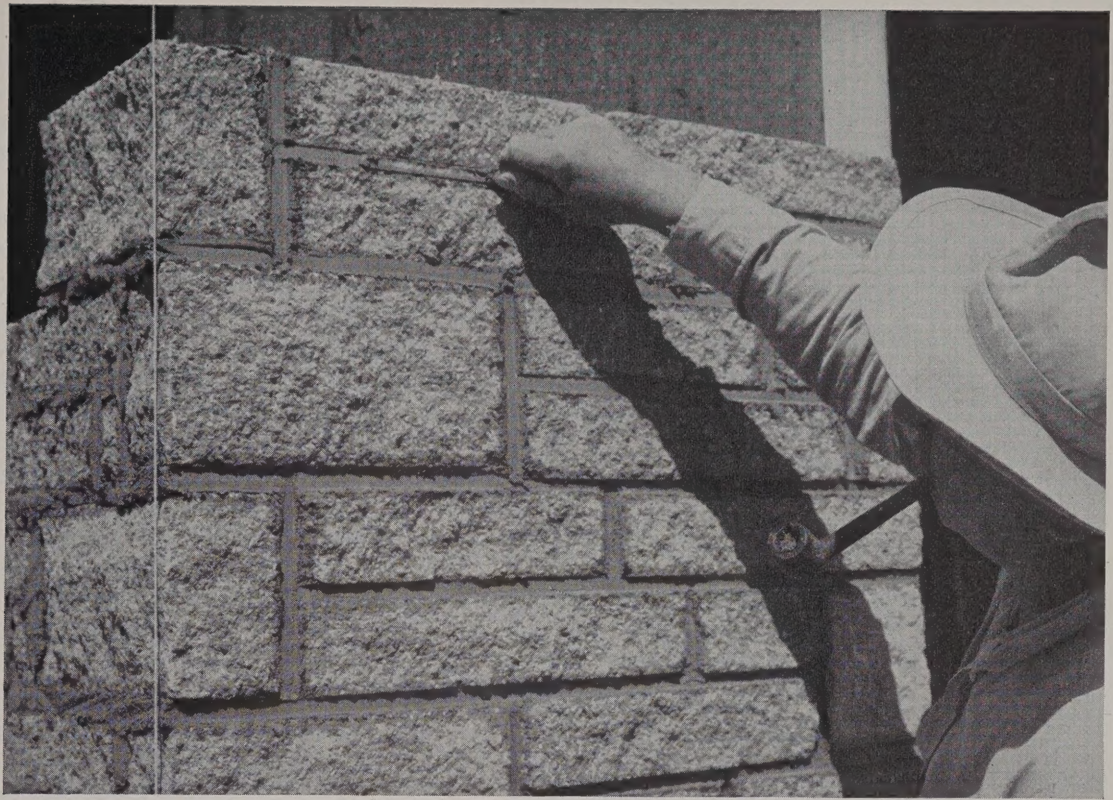
Slump block are used to achieve special and unusual architectural effects. Slump block are made with a concrete mixture of such consistency that they sag or slump when removed from the molds, with the result that the irregularly faced units vary considerably in height, surface texture and general appearance.



In extruded mortar joint construction, mortar squeezed out as block are laid is not trimmed off but is left to harden in its extruded form.



Slump block laid in an ashlar pattern.



Tooling mortar joints of concrete split-block masonry. The fractured block produce walls of rugged appearance.

Split-block afford another variation in wall finish. They are used for facing fireplaces, chimneys or the entire interior and exterior walls of the building. Split-block are made by splitting a hardened concrete unit lengthwise. The units are laid in the wall with the fractured faces exposed. Many interesting variations can be obtained by introducing mineral colors and by using aggregates of different gradings and colors in the concrete mixture. Split-block can be laid in simple broken joint patterns or in any of the other patterns used in concrete masonry construction. The fractured faces of the units produce a wall of rugged appearance.

All block intended for use in exterior walls and which will not be painted should have low absorption, with joints carefully tooled for weathertightness.

Painted Concrete Masonry Walls

The growing popularity of concrete masonry and the demand for white, or light-colored exterior surfaces has resulted in the increased use of portland cement base paints. Portland cement paint when properly applied to concrete masonry walls serves two practical purposes: (1) it provides attractive finishes and (2) helps to make masonry surfaces weathertight.

Portland cement paint is sold in powdered form in a variety of colors and is mixed with water before applying. It should meet the requirements of the Federal Specification for Paint, Serial Designation: TT-P-21, Type II, Class A or Class B. Class A paint is used where the surface texture of the masonry wall is to be preserved. Class B paint contains a filler which gives the paint more body and is used to fill open porous surfaces.

Tests* conducted on various types of paints on masonry walls have found that portland cement base paints are highly effective as weatherproofing and that they have a high durability rating.

The normal exterior concrete masonry wall treatment consists of two coats of portland cement paint. Where walls are constructed of dense block with weathertight joints, and paint is used only for its color, one coat of paint ordinarily will be sufficient.

One coat of portland cement paint is usually adequate for interior walls where weathertightness is not a factor. Surface texture as well as sound absorption values are better preserved when one instead of two coats of paint is used.

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*BMS 95, *Tests of Cement-Water Paints and Other Waterproofings for Unit-Masonry Walls*, by Cyrus C. Fishburn and Douglas E. Parsons, issued March 15, 1943; and BMS 110, *Paints for Exterior Masonry Walls*, by Clara Sentel, issued November 15, 1947. Copies for sale by Superintendent of Documents, Washington 25, D.C.—Price 15 cents. "Tests of the Resistance to Rain Penetration of Walls Built of Masonry and Concrete," by R. E. Copeland and C. C. Carlson, American Concrete Institute, *Proceedings*, Vol. 36, p. 169.

Surface of concrete masonry wall is uniformly dampened with water fog spray just prior to application of portland cement base paints. A garden pressure sprayer with a fine fog nozzle is recommended for this purpose.

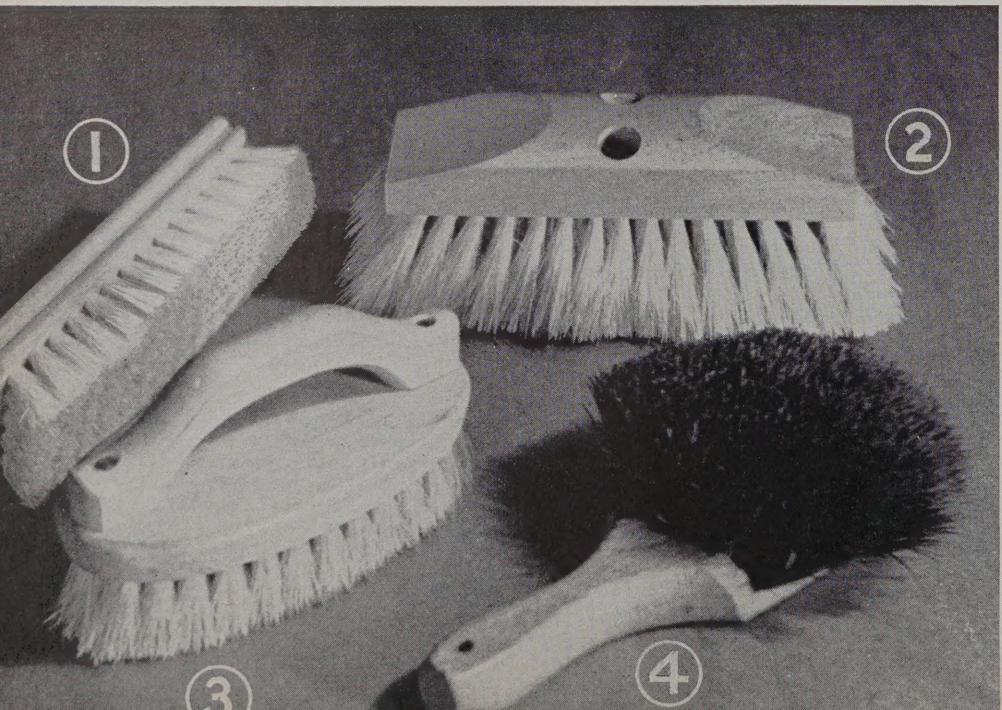
Portland cement paint should be applied to surfaces which are clean and free from oil, oil paint, dirt, or any substance which will prevent proper adhesion. Cracks or other wall imperfections should be cleaned of loose particles, dampened and filled with a stiff portland cement grout, and should be allowed to cure before painting.

The surface should be lightly *dampened but not soaked* with water before painting is begun so that the wall will not absorb mixing water needed for proper hardening of the cement paint. A garden pressure-sprayer with a fine fog spray nozzle is recommended for this purpose. The surface should be uniformly damp but not wet when painted. All flashing, hangers, fasteners, trim and other fixed supports should be in place before painting is started.

Portland cement base paint should be prepared by mixing with water in the manner and to the consistency recommended in the instructions furnished by the manufacturer. Frequent stirring is necessary to keep the paint powder in suspension. A shallow pan 4 to 6 in. deep and 12 in. or more wide provides a good container. In such a pan the paint can be stirred easily and quickly. When the pan is filled to a depth of only 2 or 3 in. the paint can be stirred by the painter as he refills his brush.

Brushes with stiff fiber bristles not over 2 in. long, such as scrub and fender brushes, should be used to scrub the paint into surface pores. Brushes should be designed to keep the hands from unnecessary contact with the paint, as tender or sensitive skin may become irritated by prolonged contact with cement paint. The use of rubber gloves is advisable in some instances.

The first coat, when scrubbed into the surface, will eliminate any small pinholes through which water otherwise might enter the wall. Mortar joints around each block should be painted first.



Typical brushes used in applying portland cement paint:

1. **Ordinary scrub brush**
2. **Window brush**
3. **Brush with handle**
4. **Fender brush**

When the first coat has hardened sufficiently, usually not sooner than 12 hours, the second coat should be applied after first dampening the surface. After the painting has been started it should be continued to some natural stopping point such as corners, doors, belt courses, etc. Frequent stirring of the paint is essential.

Paint should not be applied to frosty surfaces nor should painting be attempted if the temperature is likely to be below 40 deg. F. during the following 12 hours.

Properly applied and cured, portland cement paint bonds to and becomes a part of the concrete masonry wall, sealing the mortar joints and block surfaces.

High winds, excessive heat and strong sunshine will dry cement paint quickly and render it ineffective as a weathertight coating unless it is properly moist cured. Improperly cured portland cement base paints may chalk or dust. The first coat should, therefore, be kept in a slightly damp condition for at least 12 hours and the finish coat for 48 hours. Keeping the paint moist with a fine fog spray should start as soon as the paint is hard enough to resist damage.

Two-tone effects can be produced by applying first and second coats of different but harmonizing colors—as for example, a first coat of light brown and a second coat of cream. In this treatment the second coat is usually painted lightly over the first, touching only the high spots and being careful not to brush paint into the depressions. Another variation of this method is to rub off part of the second coat producing a mottled effect. A variety of other color combinations can be used depending on the skill of the painter and the decorative effect desired.

Only light pastel shades of portland cement base paint are recommended for painting exterior concrete masonry walls.

On jobs where a particular color effect is desired it is recommended that paint selection be determined by painting sample wall panels. This is important because the color of a painted wall will vary somewhat depending upon the kind of aggregate in the concrete block, the rate and amount of absorption, the method of curing the paint and other factors. Sample walls should be constructed as described in Sample Panels, page 39. The paint should be applied and cured in the same manner as will be used on the walls of the building. As an alternative for the sample panels, the paint can be applied to sections of the building wall.

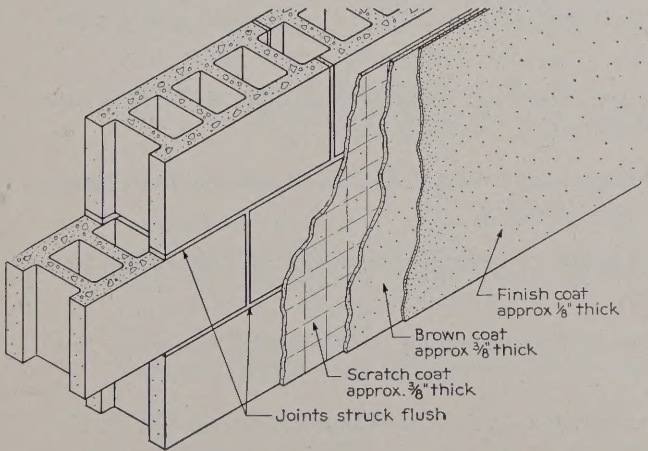
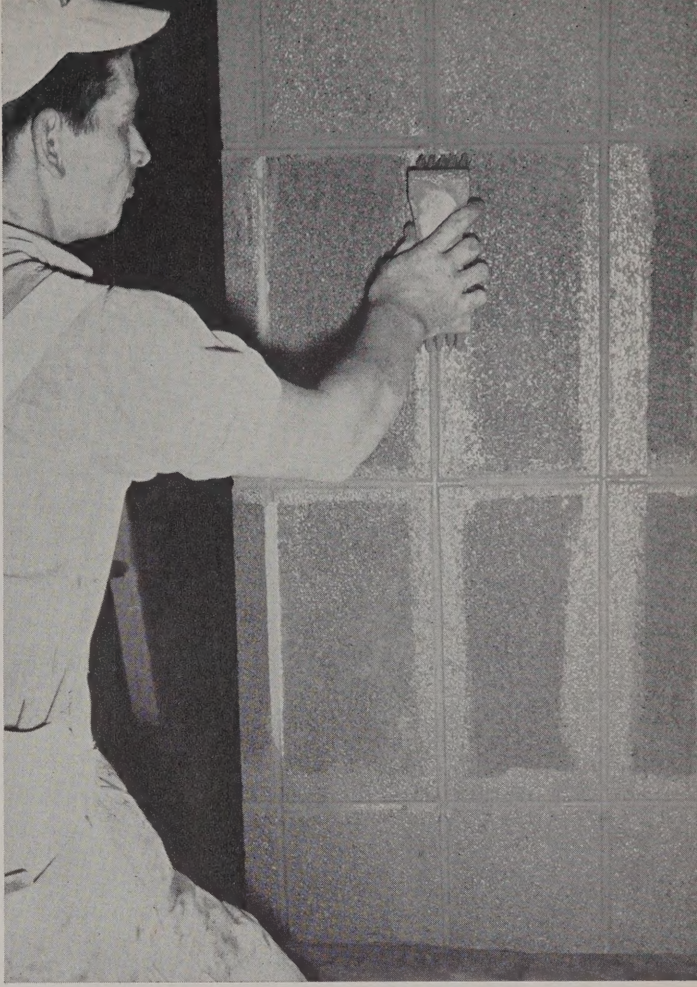

Finish coat approx ⅛" thick
Brown coat approx ⅜" thick
Scratch coat approx. ⅜" thick
Joints struck flush

Fig. 24—Application of portland cement stucco to concrete masonry walls. Similar construction is used for portland cement plaster.



Recommended practice is to paint joints first.

Concrete masonry is an excellent surface for the application of other types of paints. Manufacturer's instructions for applying these paints should be followed.

Stuccoed or Plastered Walls

Concrete masonry walls provide good bond for portland cement stucco and plaster finishes. For details on the application of portland cement stucco and portland cement plaster to walls of concrete masonry, see the specifications of the American Standards Association* and the Plasterer's Manual.**

**Standard Specifications for Portland Cement Stucco and Portland Cement Plastering* (A42.2 and A42.3), published by the American Standards Association.

***Plasterer's Manual*, published by the Portland Cement Association.

Reference List on Concrete Masonry

American Standard Building Code Requirements for Masonry, *Miscellaneous Publications M-174,* U.S. Department of Commerce, Washington, D.C.*

ASTM Specifications for Concrete Masonry Units:†

- Hollow Load-Bearing Concrete Masonry Units (C90-44).
- Hollow Non-Load-Bearing Concrete Masonry Units (C129-39).
- Solid Load-Bearing Concrete Masonry Units (C145-40).
- Concrete Masonry Units for Construction of Catch-Basins and Manholes (C139-39).
- Concrete Building Brick (C55-37).
- Standard Methods of Sampling and Testing Concrete Masonry Units (C140-39).

Federal Specifications for Concrete-Units: Masonry, Hollow (SS-C-621).* Federal Specifications' Board, Washington, D.C.

Standard for Concrete Masonry Units, Underwriters' Laboratories, Inc.**

Simplified Practice Recommendation R 32-38: Concrete Building Units. U.S.Department of Commerce, Washington, D.C.*

Project A-62 for Coordination of Dimensions of Building Materials and Equipment. American Standards Association, 29 West 39th Street, New York, N.Y.

"Strength and Stability of Concrete Masonry Walls," ***by F. E. Richart, R. B. B. Moorman and P. M. Woodworth.*** *Bulletin No. 251,* Engineering Experiment Station, University of Illinois.**

"Effect of Mortar Strength and Strength of Unit on the Strength of Concrete Masonry Walls," ***by R. E. Copeland and A. G. Timms.*** *Journal,* American Concrete Institute, Vol. 3, p. 551.

"Tests of the Stability of Concrete Masonry Walls," ***by F. E. Richart, P. M. Woodworth and R. B. B. Moorman.*** *Proceedings,* American Society for Testing Materials, Vol. 31, Part II, p. 687.

"The Structural Performance of Concrete Masonry Walls," ***by F. E. Richart.*** *Journal,* American Concrete Institute, Vol. 3, No. 6, p. 363.

"Tests of the Fire Resistance and Stability of Walls of Concrete Masonry Units," ***by C. A. Menzel.*** *Proceedings,* American Society for Testing Materials, Vol. 31, Part II, p. 607.

"The Strength of Concrete Masonry Walls After Standard Fire Exposure," ***by C. A. Menzel.*** *Journal,* American Concrete Institute, Vol. 4, p. 113.

"Tests on Concrete Masonry Units Using Tamping and Vibration Molding Methods," ***by K. F. Wendt and P. M. Woodworth.**** *Proceedings,* American Concrete Institute, Vol. 36, p. 121.

"Strength of Concrete Block Pilasters Under Varied Eccentric Loading," ***by J. R. Shank and H. D. Foster.*** *Bulletin No. 60,* Engineering Experiment Station, Ohio State University.

Tests of the Fire Resistance and Strength of Walls of Concrete Masonry Units, ***by C. A. Menzel.*** Portland Cement Association, Chicago, Ill.

Heating Ventilating Air Conditioning Guide, American Society of Heating and Ventilating Engineers, New York, N.Y.

"Thermal Insulation of Concrete Homes," ***by Arthur Stone.*** *Journal,* American Concrete Institute, Vol. 19, No. 9, p. 849.

"Thermal Properties of Concrete Construction," ***by F. B. Rowley, A. B. Algren and C. C. Carlson.*** *Heating, Piping and Air Conditioning,* January 1936.

"Thermal Properties of Concrete Construction (Part 2)," *by F. B. Rowley, A. B. Algren and Robert Lander. Heating, Piping and Air Conditioning*, November 1936.

Acoustics and Architecture, *by Paul E. Sabine.* McGraw-Hill Book Company, Inc., New York and London, 1932.

"Sound-Absorbing Value of Portland Cement Concrete," *by F. R. Watson and K. C. Morrical. Proceedings*, American Concrete Institute, Vol. 32, p. 659.

"The Nature of Portland Cement Paints and Proposed Recommended Practice for Their Application to Concrete Surfaces," *Journal*, American Concrete Institute, Vol. 13, No. 6, p. 485.

Standard for Recommended Practice for the Application of Portland Cement Paint to Concrete Surfaces (ACI 616-49), American Concrete Institute.

"Comparative Tests of Clay, Sand-Lime and Concrete Brick Masonry," *by A. H. Beyer and W. J. Krefeld. Bulletin No. 2*, Department of Civil Engineering, Columbia University.

"Concrete Masonry," *by Amund Korsmo.* Reprinted from HHFA Technical Bulletin No. 9 (March 1949).*

"Tests of the Resistance to Rain Penetration of Walls Built of Masonry and Concrete," *by R. E. Copeland and C. C. Carlson. Proceedings*, American Concrete Institute, vol. 36, p. 169.**

"Good Practice in Concrete Masonry Wall Construction," *by Kenneth C. Tippy. Proceedings*, American Concrete Institute, vol. 38, p. 317.

Bureau of Standards publications, U.S. Department of Commerce:*

No. 6—Recommended Minimum Requirements for Masonry Wall Construction.
No. 14—Recommended Minimum Requirements for Fire Resistance in Buildings.
No. 18—Recommended Minimum Requirements for Small Dwelling Construction.

Building Materials and Structural Reports:

BMS 5—Structural Properties of Six Masonry Wall Constructions.
BMS 7—Water Permeability of Masonry Walls.
BMS 17—Sound Insulation of Wall and Floor Constructions and Supplement.
BMS 21—Structural Properties of a Concrete-Block Cavity-Wall Construction.
BMS 22—Structural Properties of "Dun-Ti-Stone" Wall Construction.

BMS 32—Structural Properties of Two Brick-Concrete-Block Wall Constructions and a Concrete-Block Wall Construction.

BMS 55—Effects of Wetting and Drying on the Permeability of Masonry Walls.
BMS 82—Water Permeability of Walls Built of Masonry Units.
BMS 88—Recommended Building Code Requirements for New Dwelling Construction.
BMS 92—Fire Resistance Classifications of Building Construction.
BMS 95—Tests of Cement-Water Paints and Other Waterproofings for Unit-Masonry Walls.
BMS 110—Paints for Exterior Masonry Walls.

Suggested Specifications**

Portland Cement Stucco on Concrete Masonry Walls.
Application of Portland Cement Paint on Exposed Concrete Masonry Walls.
Concrete Footings and Concrete Masonry Walls.
Interior Wall and Ceiling Finishes.
Concrete Masonry Chimneys and Fireplaces.
Concrete Footings and Reinforced Concrete Masonry Walls.

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*Copies available from Superintendent of Documents, Government Printing Office, Washington, D.C.

**Single copies available free in the United States and Canada on request to Portland Cement Association, 33 West Grand Ave., Chicago 10, Ill.

†Copies available from American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa.

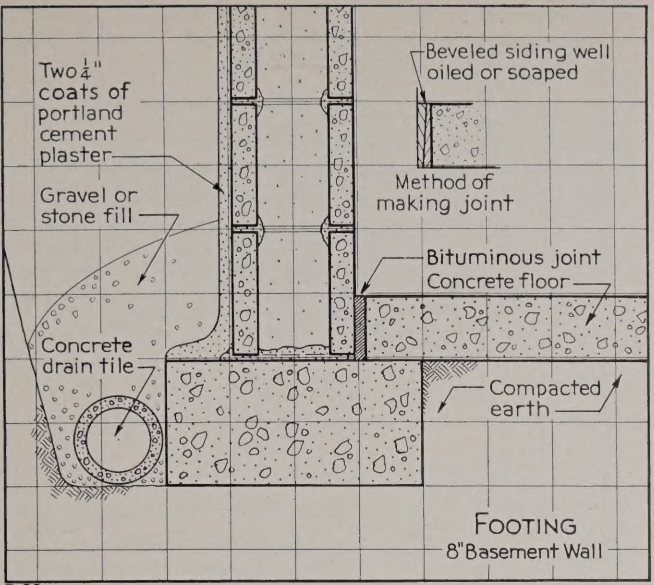
SUGGESTED DETAILS OF CONCRETE MASONRY CONSTRUCTION

On the following pages are assembled a number of drawings illustrating various recommended details for concrete masonry design and construction.

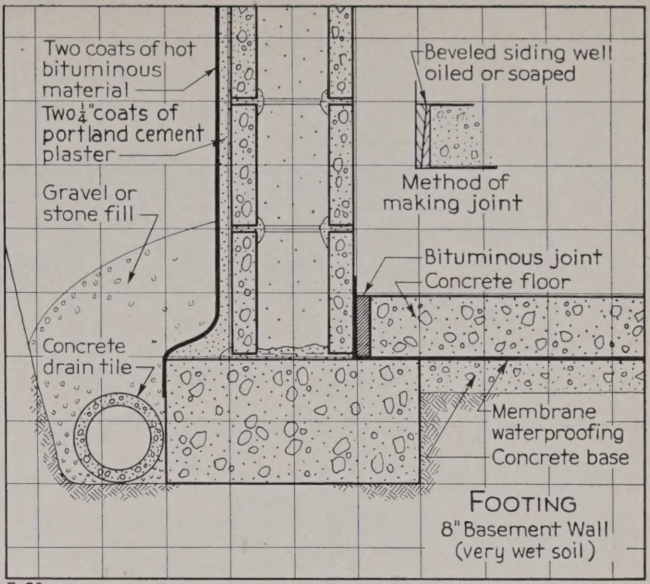
The construction details shown on pages 49 to 61 have been prepared in accordance with modular coordination of design. The grid lines shown on the drawings are module lines based on a 4-in. module. All drawings with grid lines are to a scale of 1 in. = 1 ft.

On pages 62 and 63 are shown some of the patterns used in concrete masonry construction. These may suggest other patterns to the designer.

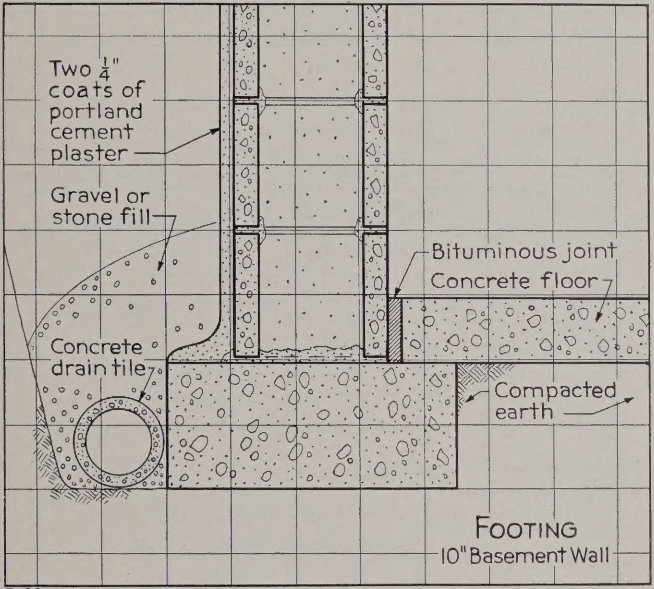
These are typical designs and should not be used as working drawings. They are intended to be helpful in the preparation of complete plans which should be adapted to local conditions and should conform with legal requirements. Working drawings should be prepared and approved by a qualified engineer or architect.


Two $\frac{1}{4}$" coats of portland cement plaster
Gravel or stone fill
Concrete drain tile
Beveled siding well oiled or soaped
Method of making joint
Bituminous joint
Concrete floor
Compacted earth
FOOTING
8" Basement Wall

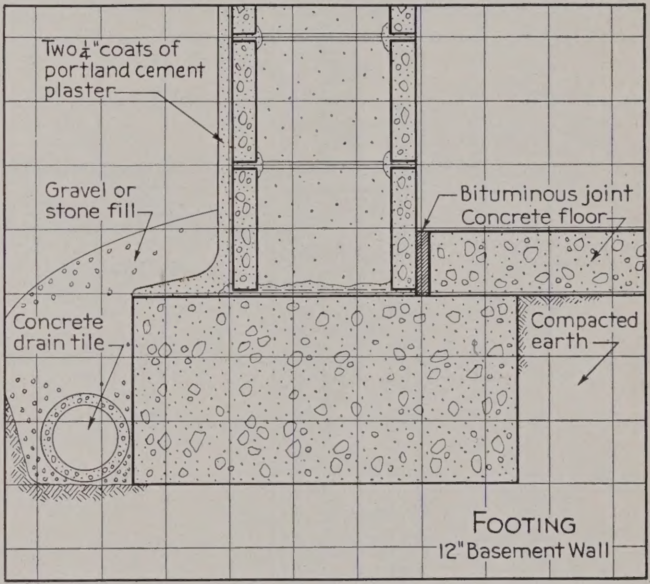
Z-25


Two coats of hot bituminous material
Two $\frac{1}{4}$" coats of portland cement plaster
Gravel or stone fill
Concrete drain tile
Beveled siding well oiled or soaped
Method of making joint
Bituminous joint
Concrete floor
Membrane waterproofing
Concrete base
FOOTING
8" Basement Wall (very wet soil)

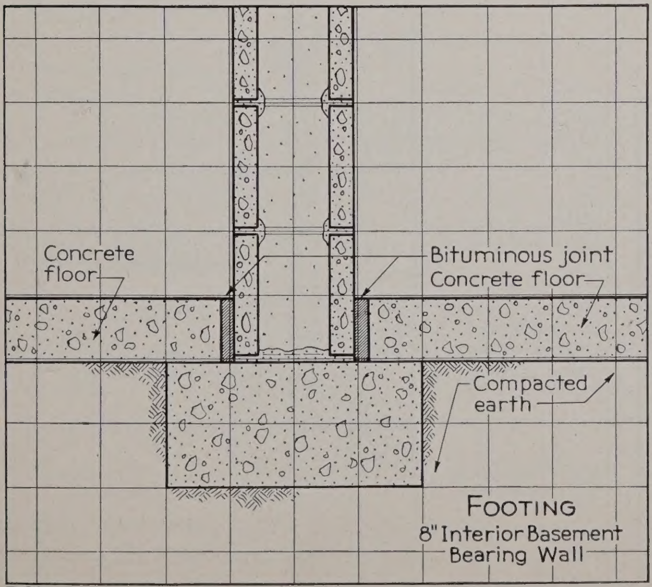
Z-26


Two $\frac{1}{4}$" coats of portland cement plaster
Gravel or stone fill
Concrete drain tile
Bituminous joint
Concrete floor
Compacted earth
FOOTING
10" Basement Wall

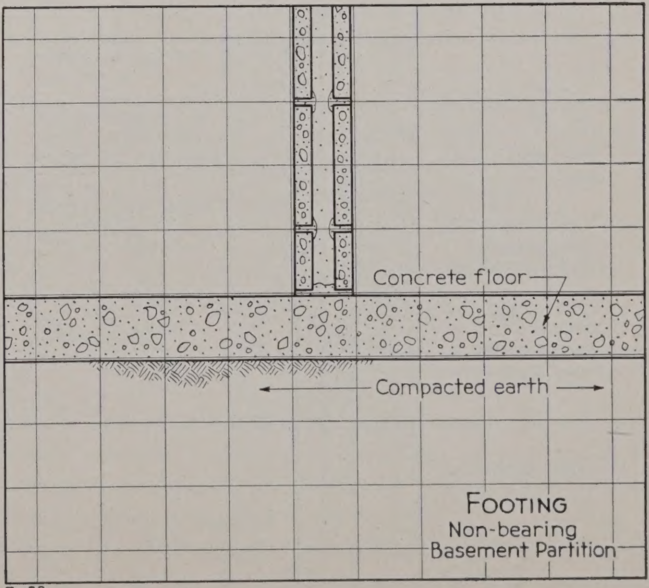
Z-28


Two $\frac{1}{4}$" coats of portland cement plaster
Gravel or stone fill
Concrete drain tile
Bituminous joint
Concrete floor
Compacted earth
FOOTING
12" Basement Wall

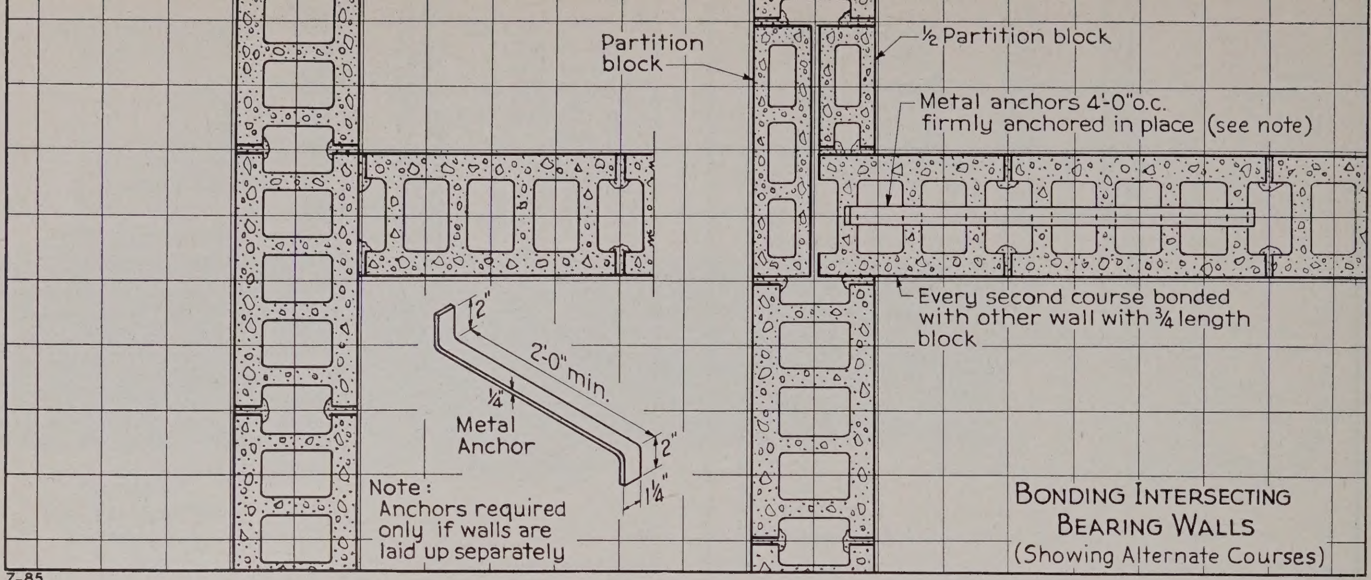
Z-29


Concrete floor
Bituminous joint
Concrete floor
Compacted earth
FOOTING
8" Interior Basement Bearing Wall

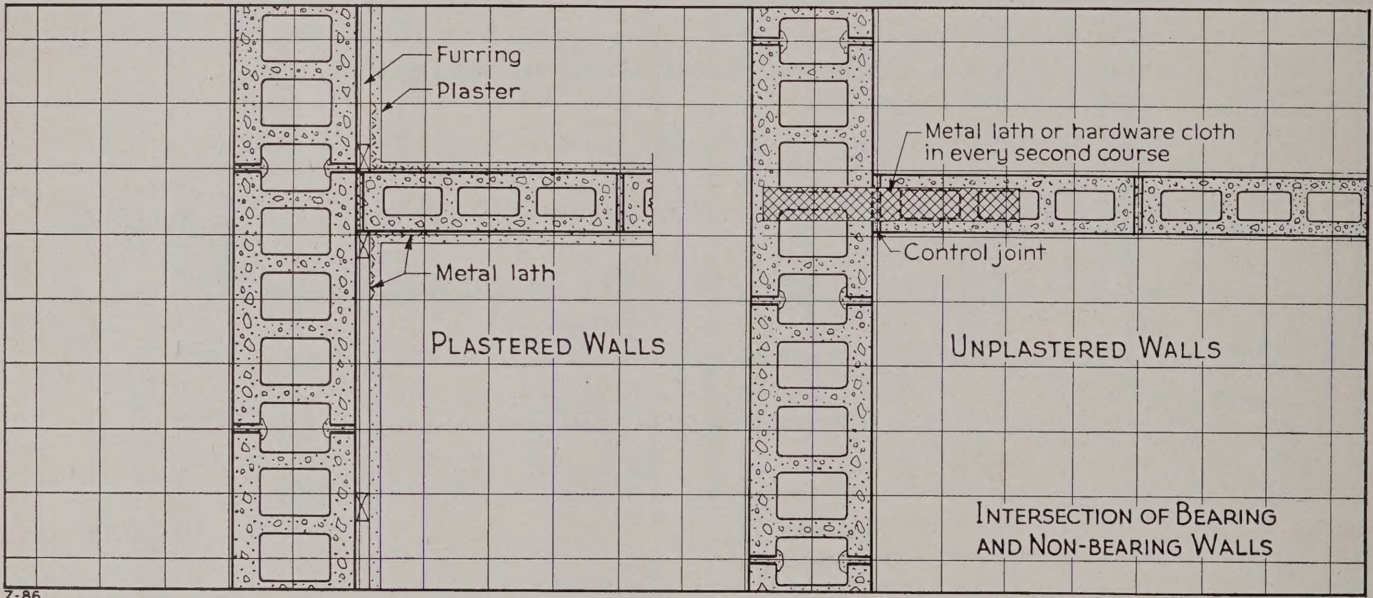
Z-30


Concrete floor
Compacted earth
FOOTING
Non-bearing Basement Partition

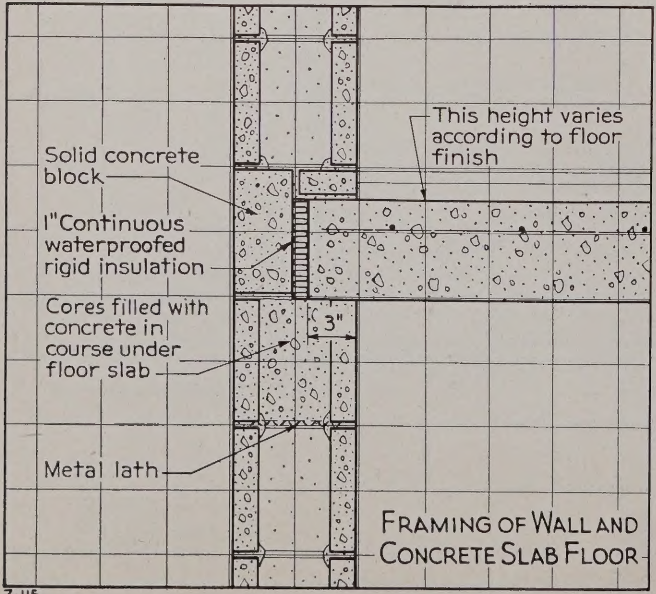
Z-33


Partition block
½ Partition block
Metal anchors 4'-0"o.c. firmly anchored in place (see note)
Every second course bonded with other wall with ¾ length block
2"
2'-0" min.
¼
Metal Anchor
2"
1¼"
Note: Anchors required only if walls are laid up separately
BONDING INTERSECTING BEARING WALLS (Showing Alternate Courses)

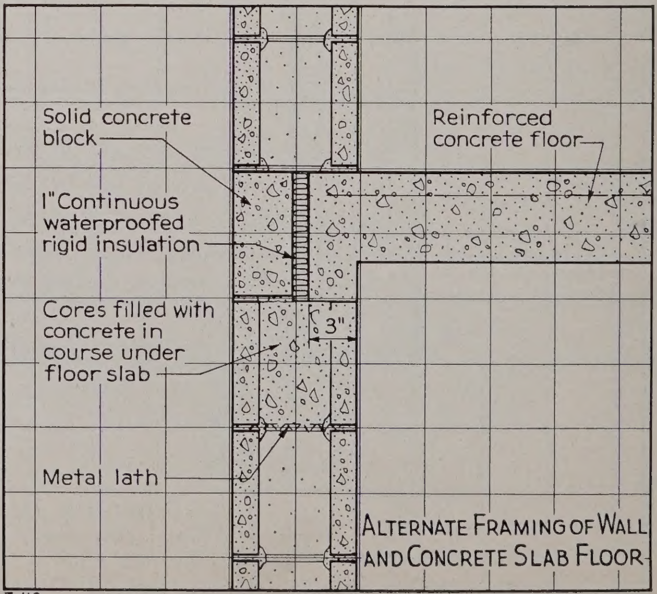
Z-85


Furring
Plaster
Metal lath
PLASTERED WALLS
Metal lath or hardware cloth in every second course
Control joint
UNPLASTERED WALLS
INTERSECTION OF BEARING AND NON-BEARING WALLS

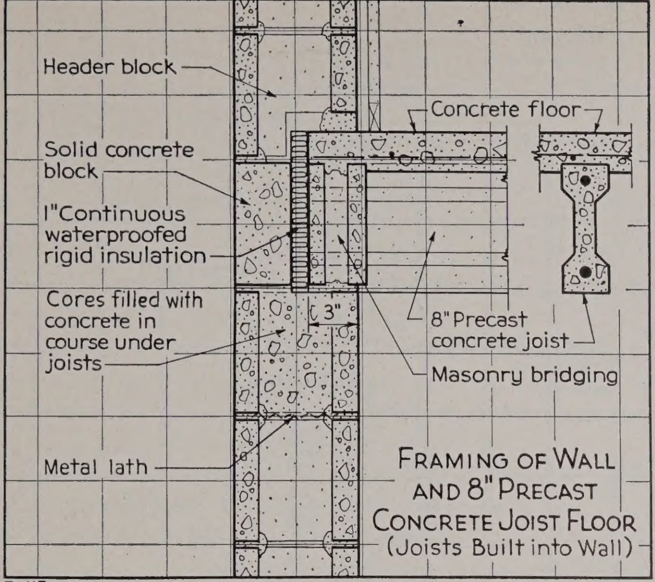
Z-86


This height varies according to floor finish
Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under floor slab
3"
Metal lath
FRAMING OF WALL AND CONCRETE SLAB FLOOR

Z-115


Solid concrete block
Reinforced concrete floor
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under floor slab
3"
Metal lath
ALTERNATE FRAMING OF WALL AND CONCRETE SLAB FLOOR

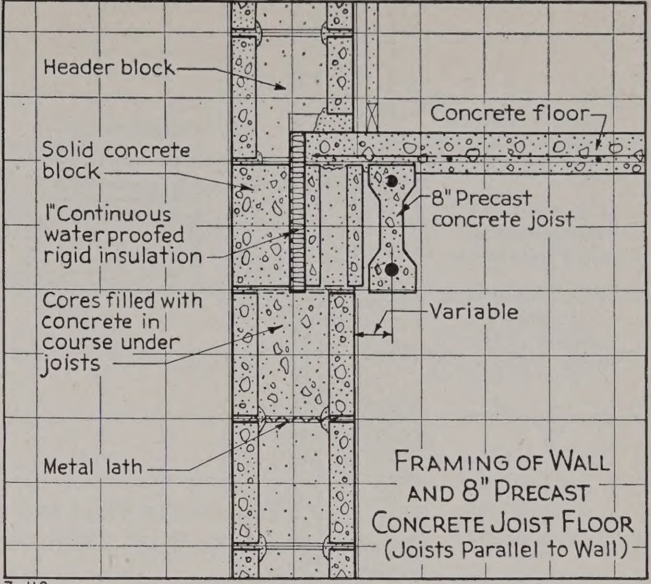
Z-116



FRAMING OF WALL AND 8" PRECAST CONCRETE JOIST FLOOR (Joists Built into Wall)

Z-117

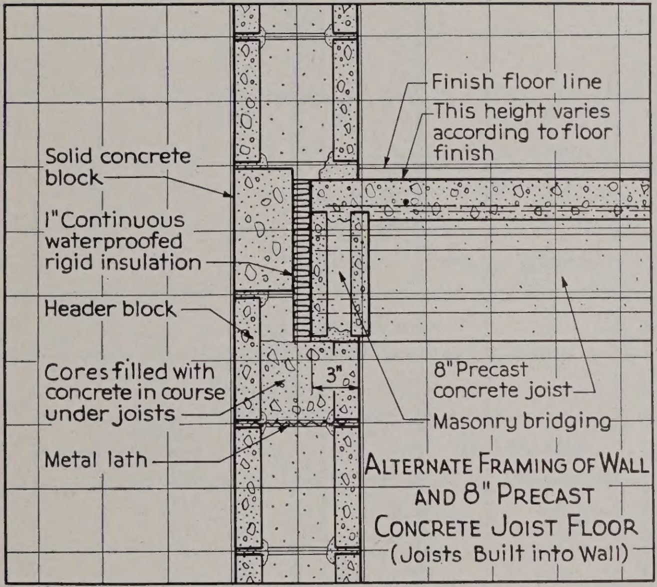
Header block
Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under joists
Metal lath
Concrete floor
3"
8" Precast concrete joist
Masonry bridging



FRAMING OF WALL AND 8" PRECAST CONCRETE JOIST FLOOR (Joists Parallel to Wall)

Z-118

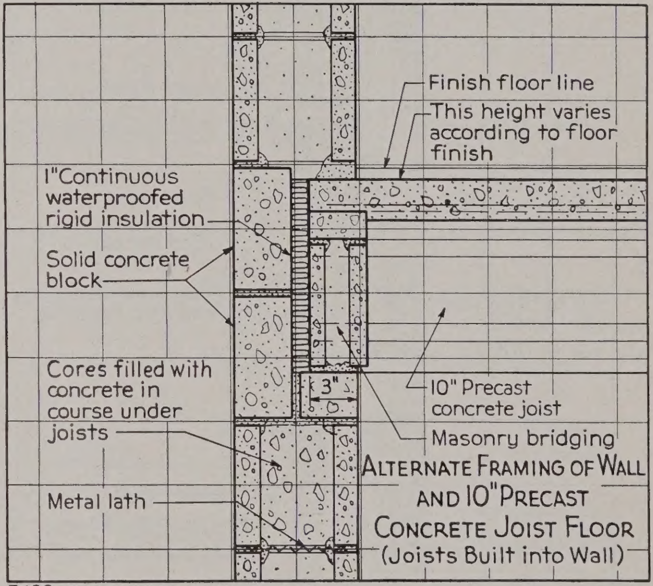
Header block
Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under joists
Metal lath
Concrete floor
8" Precast concrete joist
Variable



ALTERNATE FRAMING OF WALL AND 8" PRECAST CONCRETE JOIST FLOOR (Joists Built into Wall)

Z-119

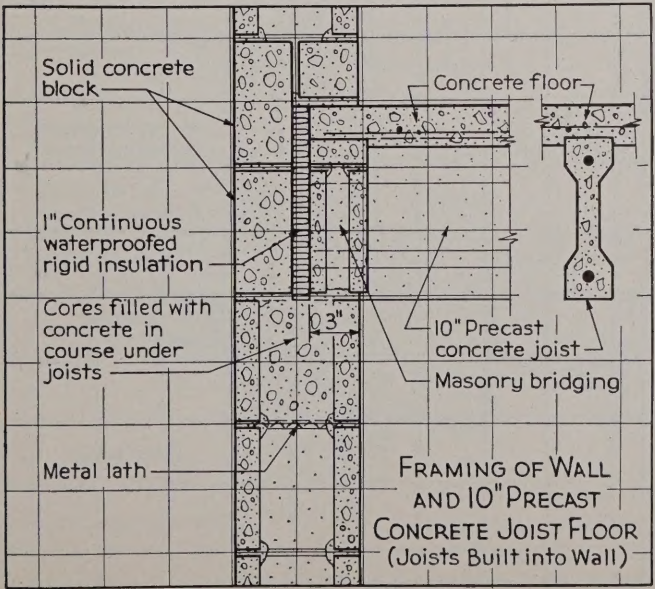
Solid concrete block
1" Continuous waterproofed rigid insulation
Header block
Cores filled with concrete in course under joists
Metal lath
Finish floor line
This height varies according to floor finish
3"
8" Precast concrete joist
Masonry bridging



ALTERNATE FRAMING OF WALL AND 10" PRECAST CONCRETE JOIST FLOOR (Joists Built into Wall)

Z-122

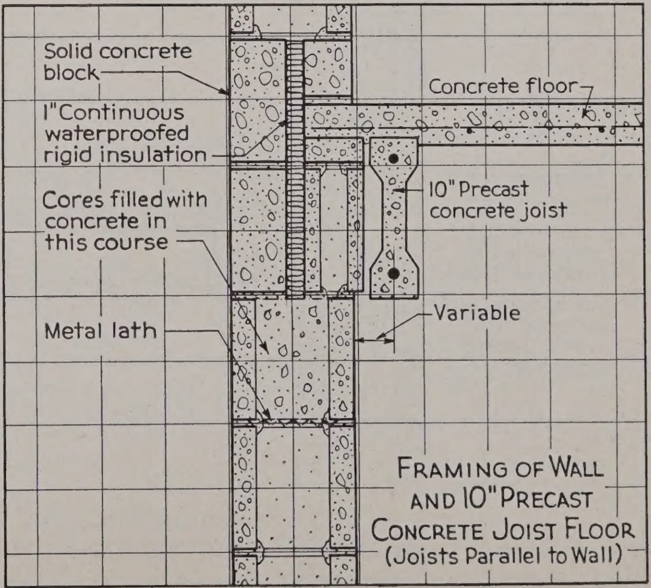
1" Continuous waterproofed rigid insulation
Solid concrete block
Cores filled with concrete in course under joists
Metal lath
Finish floor line
This height varies according to floor finish
3"
10" Precast concrete joist
Masonry bridging



FRAMING OF WALL AND 10" PRECAST CONCRETE JOIST FLOOR (Joists Built into Wall)

Z-120

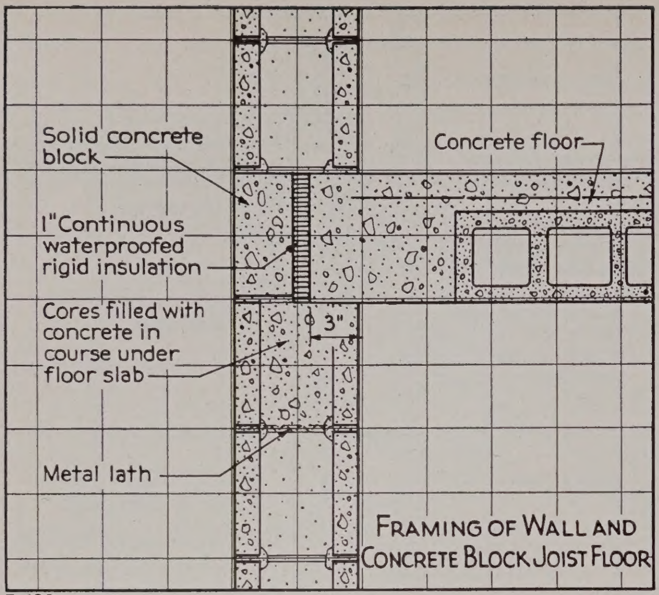
Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under joists
Metal lath
Concrete floor
3"
10" Precast concrete joist
Masonry bridging



FRAMING OF WALL AND 10" PRECAST CONCRETE JOIST FLOOR (Joists Parallel to Wall)

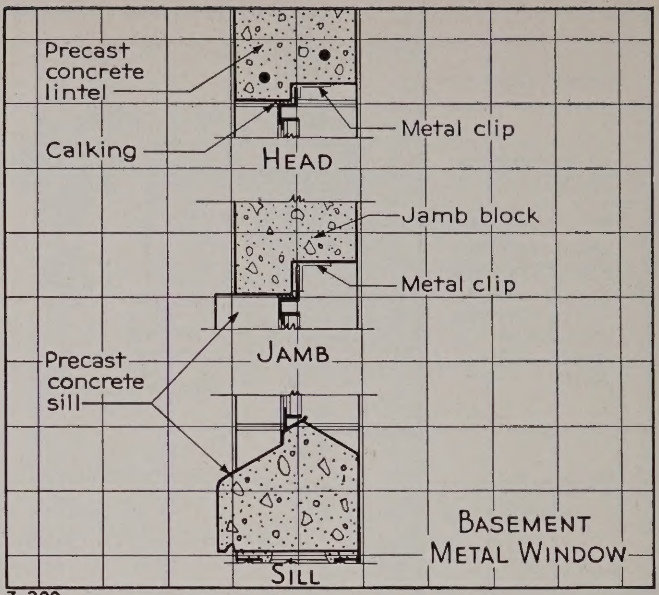
Z-121

Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in this course
Metal lath
Concrete floor
10" Precast concrete joist
Variable


Solid concrete block
Concrete floor
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under floor slab
3"
Metal lath

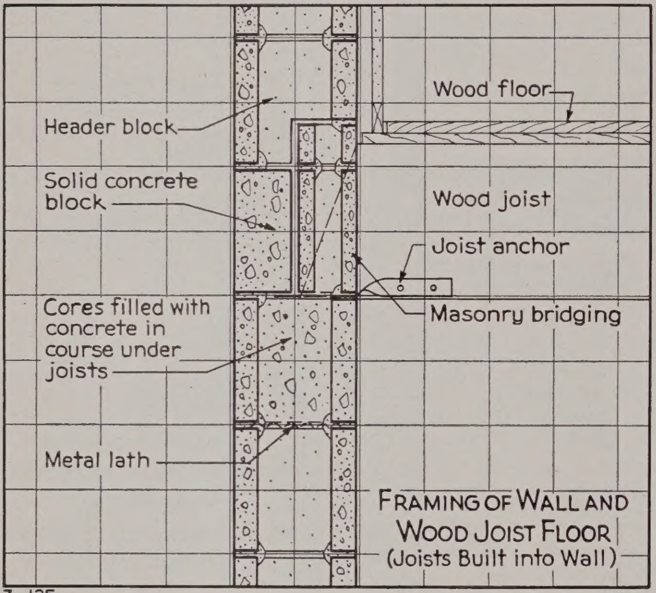
FRAMING OF WALL AND CONCRETE BLOCK JOIST FLOOR

Z-123


Precast concrete lintel
Calking
Metal clip
HEAD
Jamb block
Metal clip
JAMB
Precast concrete sill
SILL

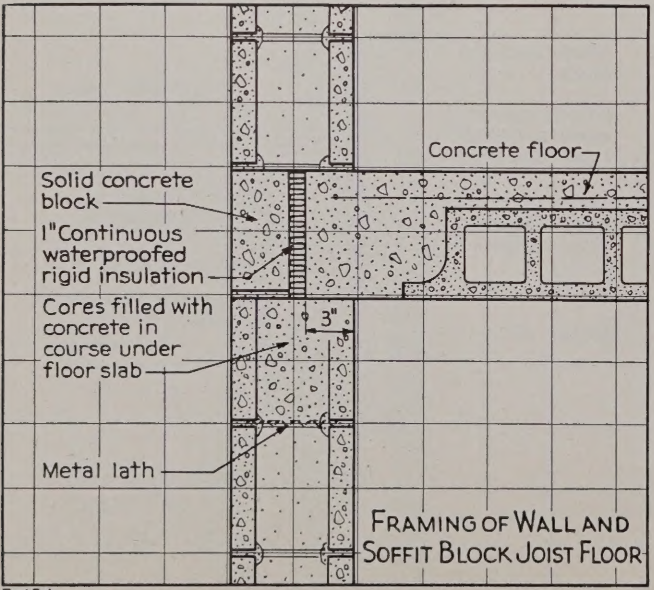
BASEMENT METAL WINDOW

Z-200


Wood floor
Header block
Solid concrete block
Wood joist
Joist anchor
Masonry bridging
Cores filled with concrete in course under joists
Metal lath

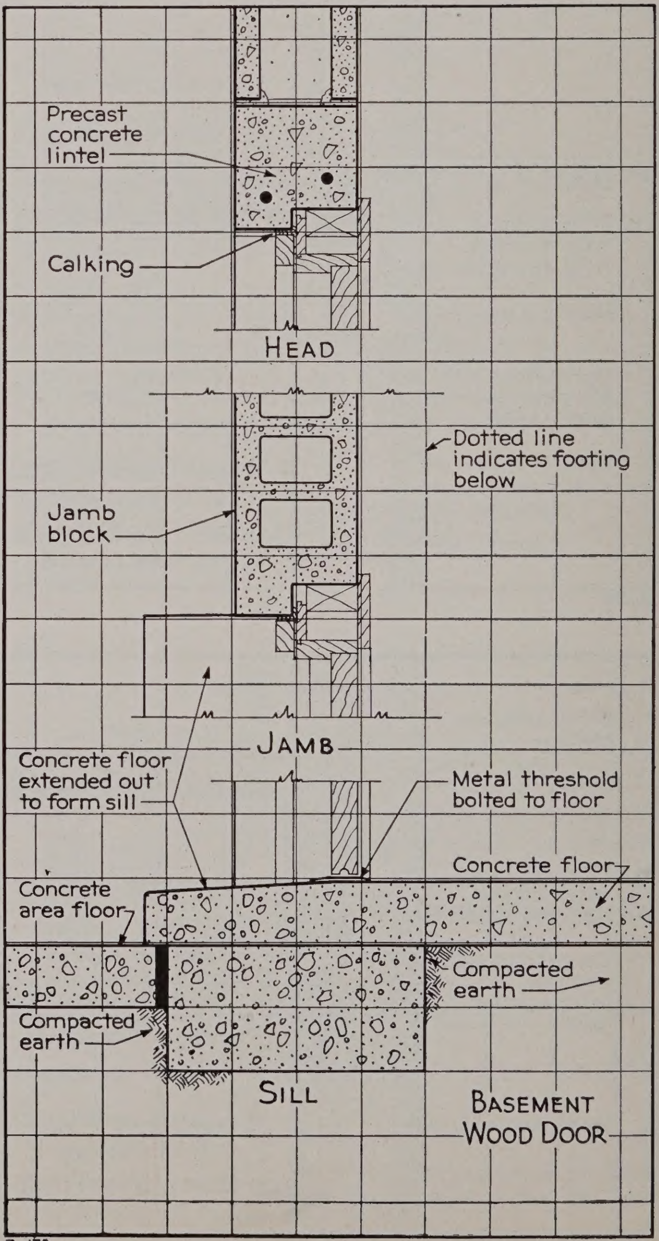
FRAMING OF WALL AND WOOD JOIST FLOOR (Joists Built into Wall)

Z-125


Concrete floor
Solid concrete block
1" Continuous waterproofed rigid insulation
Cores filled with concrete in course under floor slab
3"
Metal lath

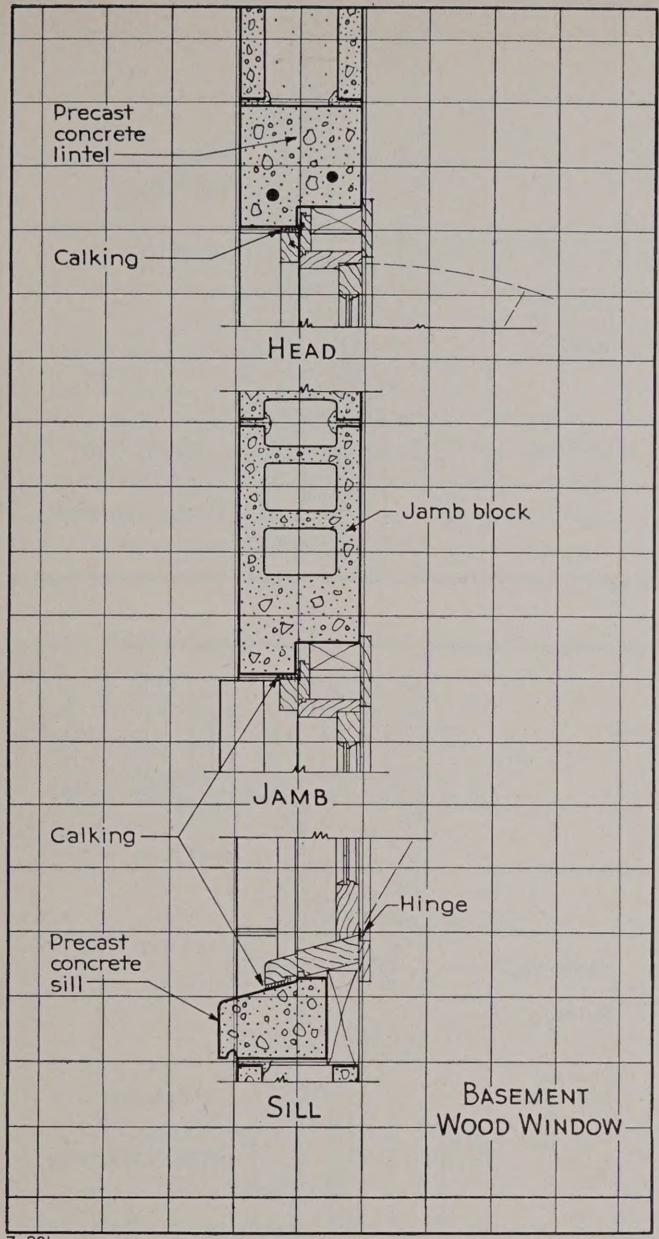
FRAMING OF WALL AND SOFFIT BLOCK JOIST FLOOR

Z-124

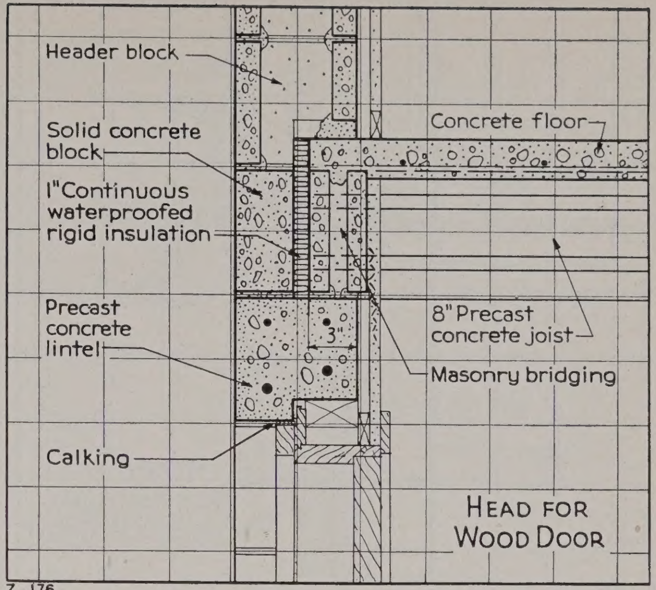

Precast concrete lintel
Calking
HEAD
Dotted line indicates footing below
Jamb block
JAMB
Concrete floor extended out to form sill
Metal threshold bolted to floor
Concrete floor
Concrete area floor
Compacted earth
Compacted earth
SILL

BASEMENT WOOD DOOR

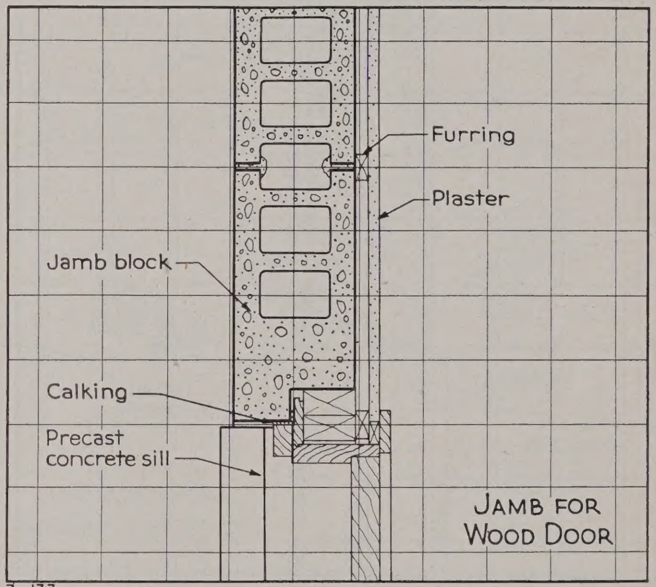
Z-175


Precast concrete lintel
Calking
HEAD
Jamb block
JAMB
Calking
Hinge
Precast concrete sill
SILL
BASEMENT WOOD WINDOW

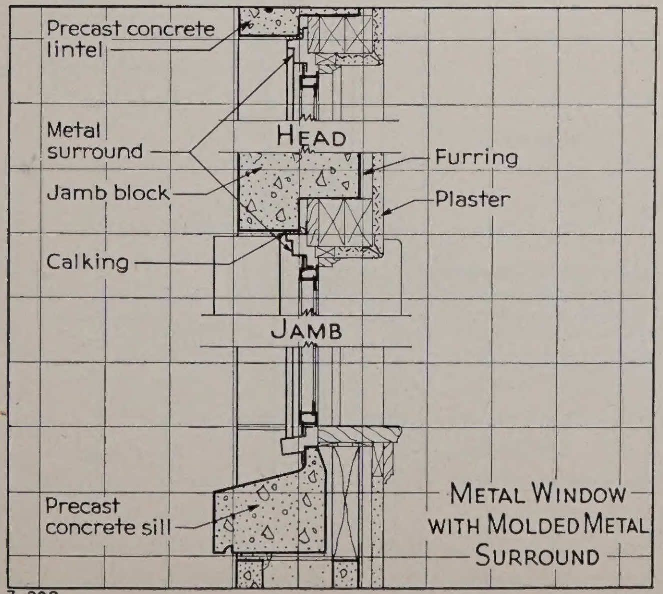
Z-201


Header block
Solid concrete block
1" Continuous waterproofed rigid insulation
Concrete floor
8" Precast concrete joist
3"
Masonry bridging
Precast concrete lintel
Calking
HEAD FOR WOOD DOOR

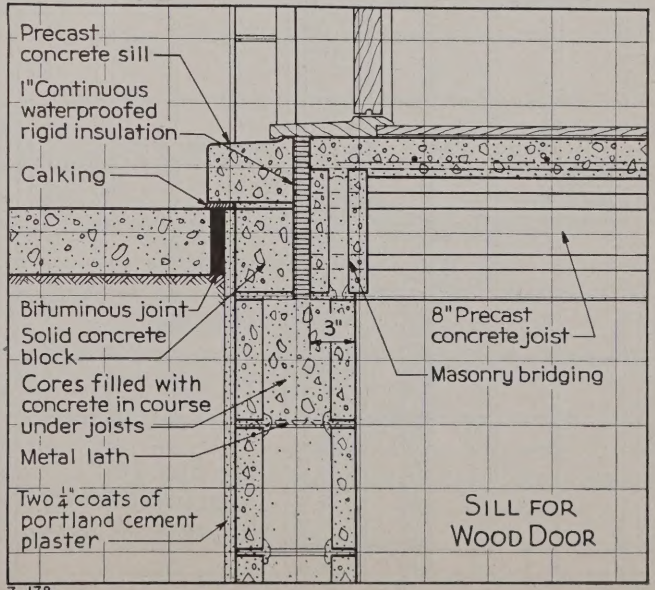
Z-176


Furring
Plaster
Jamb block
Calking
Precast concrete sill
JAMB FOR WOOD DOOR

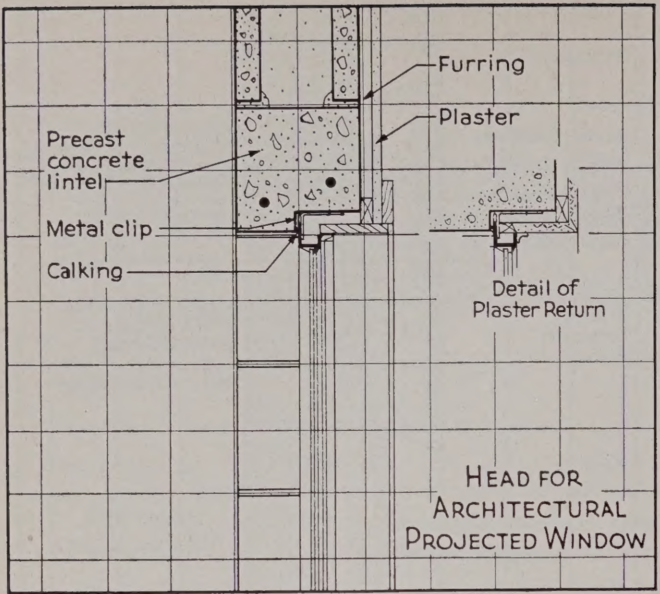
Z-177


Precast concrete lintel
Metal surround
HEAD
Furring
Jamb block
Plaster
Calking
JAMB
Precast concrete sill
METAL WINDOW WITH MOLDED METAL SURROUND

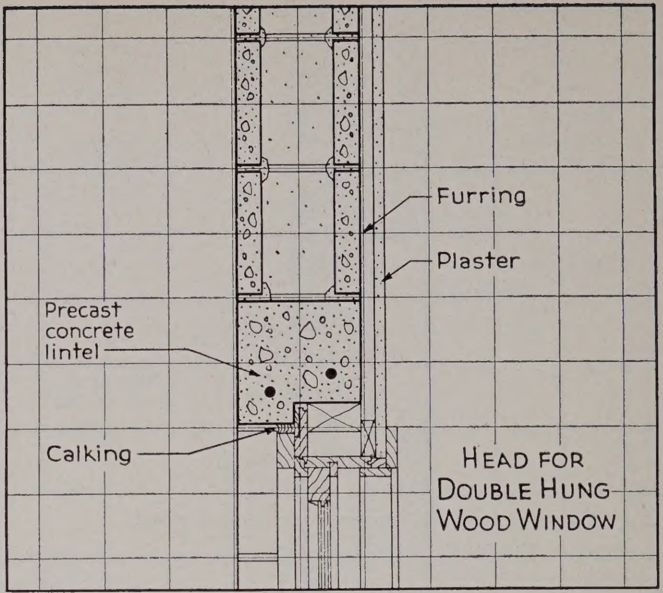
Z-202


Precast concrete sill
1" Continuous waterproofed rigid insulation
Calking
Bituminous joint
Solid concrete block
Cores filled with concrete in course under joists
Metal lath
Two ¼" coats of portland cement plaster
3"
8" Precast concrete joist
Masonry bridging
SILL FOR WOOD DOOR

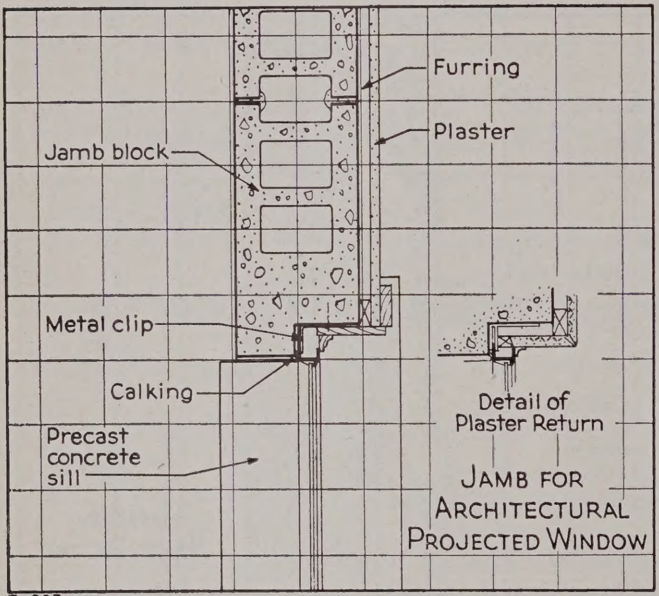
Z-178


Furring
Plaster
Precast concrete lintel
Metal clip
Calking
Detail of Plaster Return
HEAD FOR ARCHITECTURAL PROJECTED WINDOW

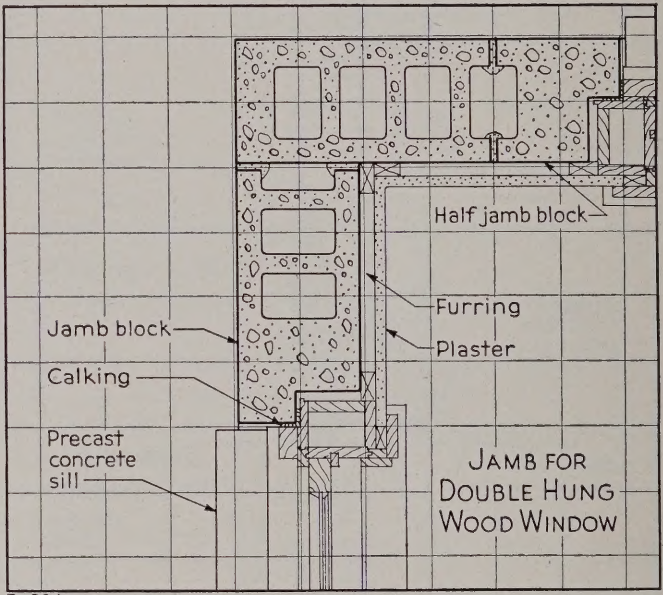
Z-206


Furring
Plaster
Precast concrete lintel
Calking
HEAD FOR DOUBLE HUNG WOOD WINDOW

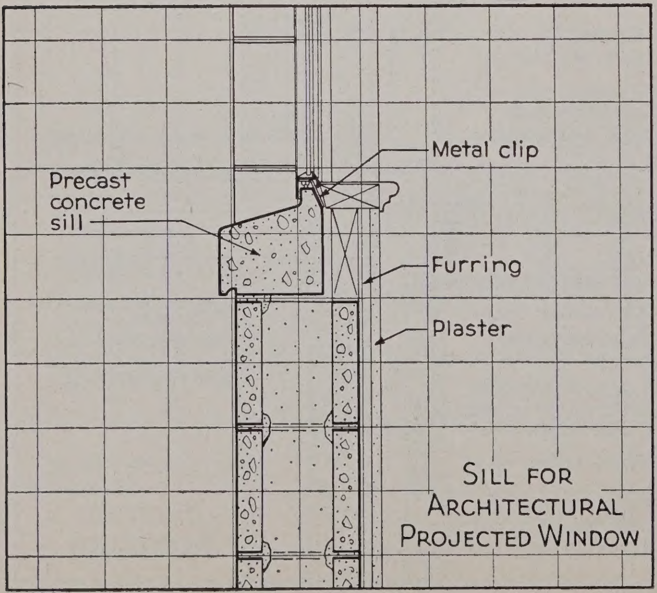
Z-203


Furring
Plaster
Jamb block
Metal clip
Calking
Precast concrete sill
Detail of Plaster Return
JAMB FOR ARCHITECTURAL PROJECTED WINDOW

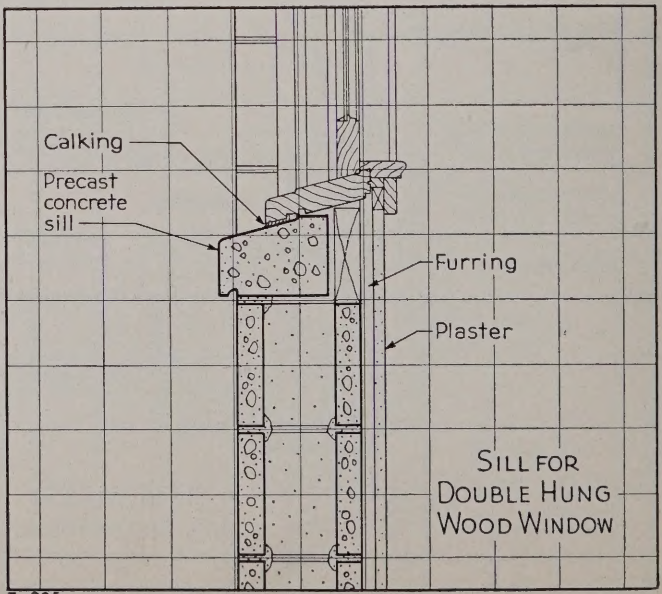
Z-207


Half jamb block
Furring
Plaster
Jamb block
Calking
Precast concrete sill
JAMB FOR DOUBLE HUNG WOOD WINDOW

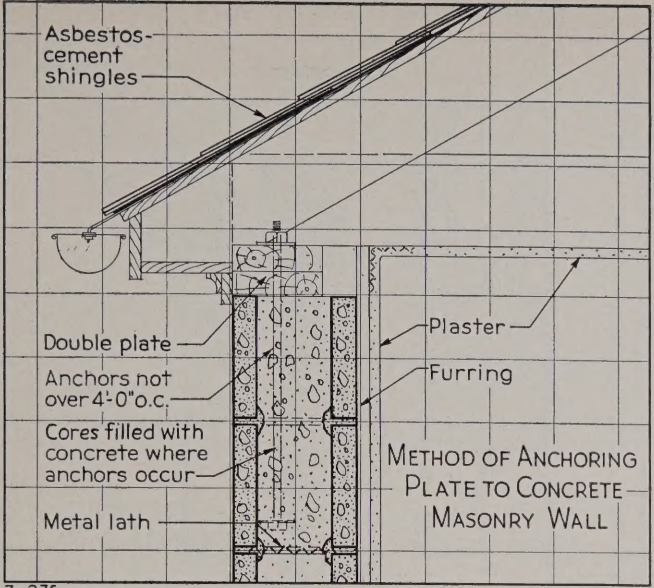
Z-204


Metal clip
Precast concrete sill
Furring
Plaster
SILL FOR ARCHITECTURAL PROJECTED WINDOW

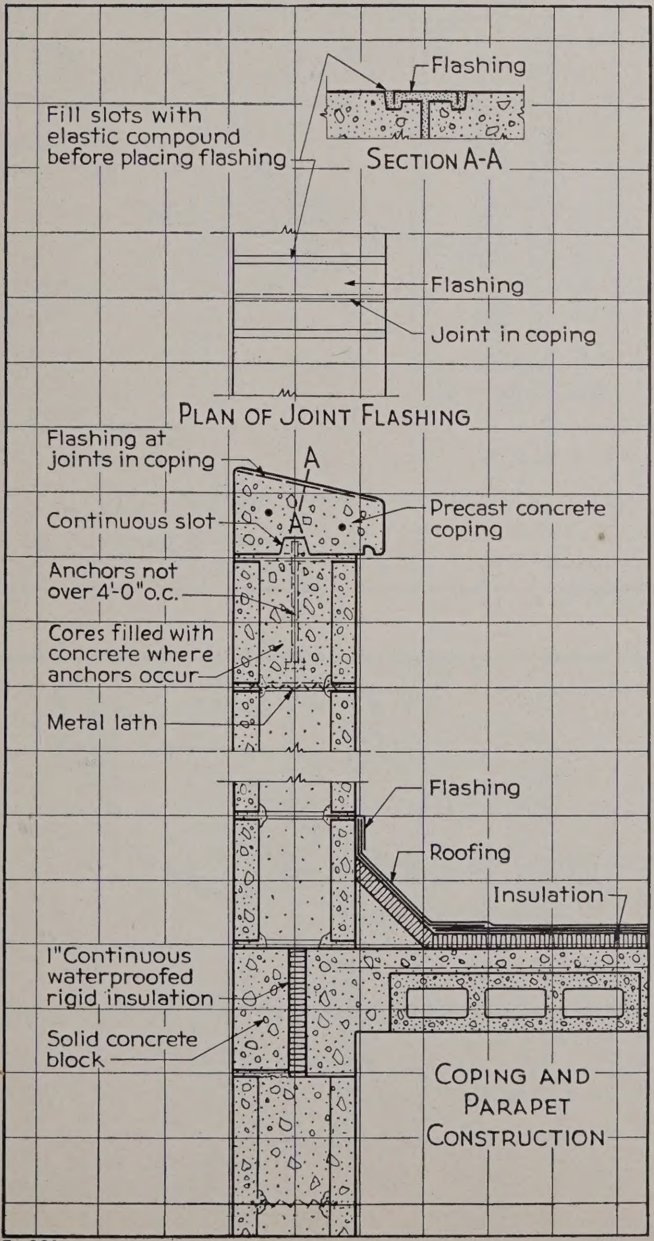
Z-208


Calking
Precast concrete sill
Furring
Plaster
SILL FOR DOUBLE HUNG WOOD WINDOW

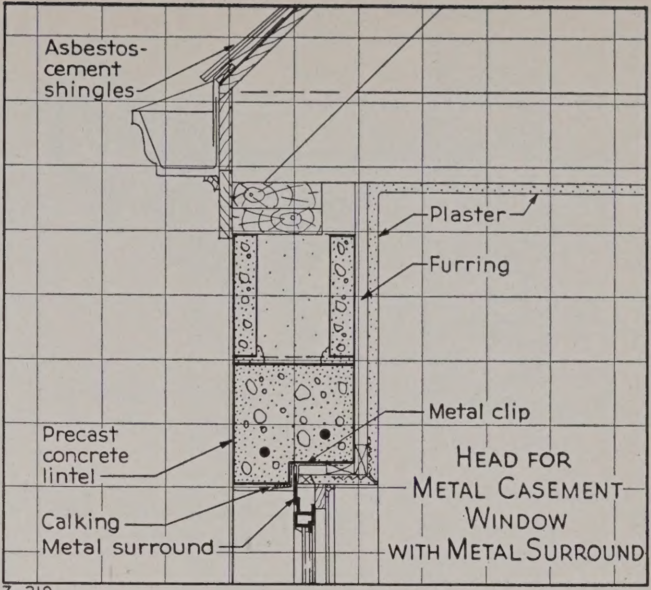
Z-205


Asbestos-cement shingles
Double plate
Anchors not over 4'-0"o.c.
Cores filled with concrete where anchors occur
Metal lath
Plaster
Furring
METHOD OF ANCHORING PLATE TO CONCRETE MASONRY WALL

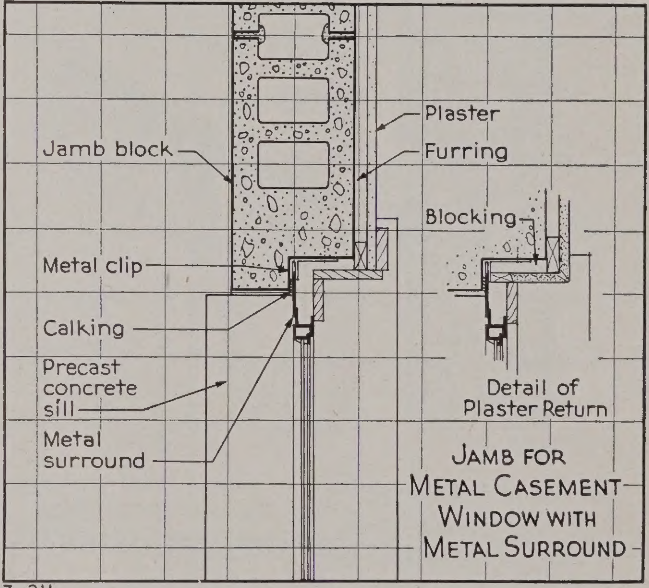
Z-275


Flashing
Fill slots with elastic compound before placing flashing
SECTION A-A
Flashing
Joint in coping
PLAN OF JOINT FLASHING
Flashing at joints in coping
A
Continuous slot
A
Precast concrete coping
Anchors not over 4'-0"o.c.
Cores filled with concrete where anchors occur
Metal lath
Flashing
Roofing
Insulation
1"Continuous waterproofed rigid insulation
Solid concrete block
COPING AND PARAPET CONSTRUCTION

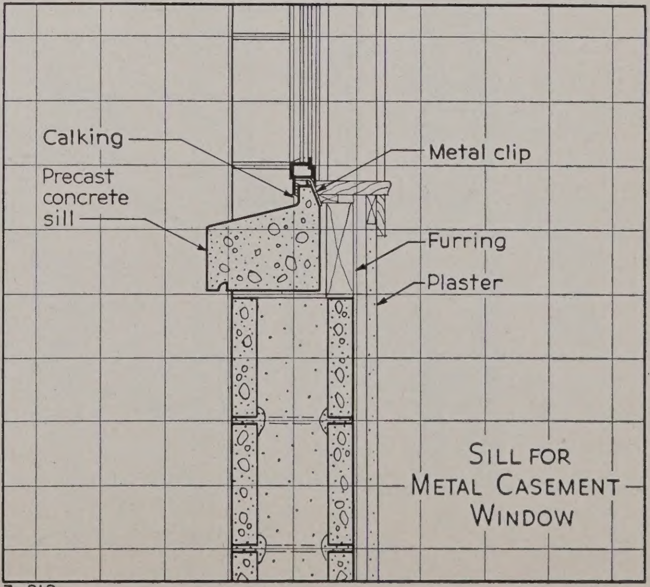
Z-220


Asbestos-cement shingles
Plaster
Furring
Metal clip
Precast concrete lintel
Calking
Metal surround
HEAD FOR METAL CASEMENT WINDOW WITH METAL SURROUND

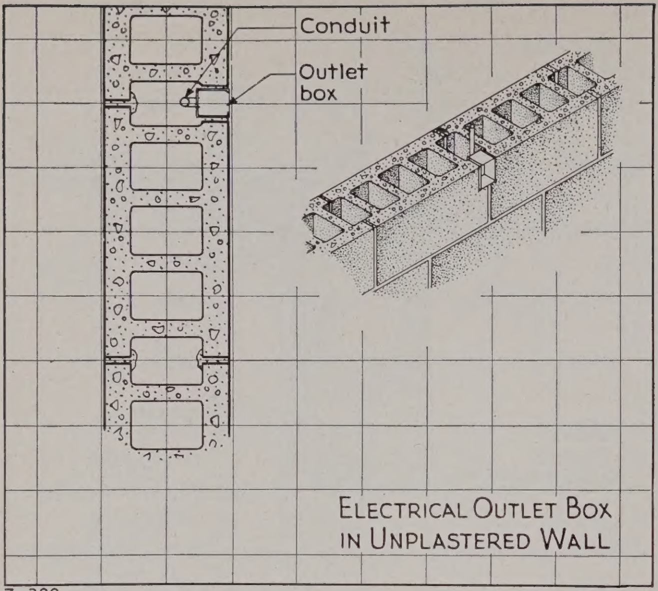
Z-210


Plaster
Jamb block
Furring
Blocking
Metal clip
Calking
Precast concrete sill
Metal surround
Detail of Plaster Return
JAMB FOR METAL CASEMENT WINDOW WITH METAL SURROUND

Z-211

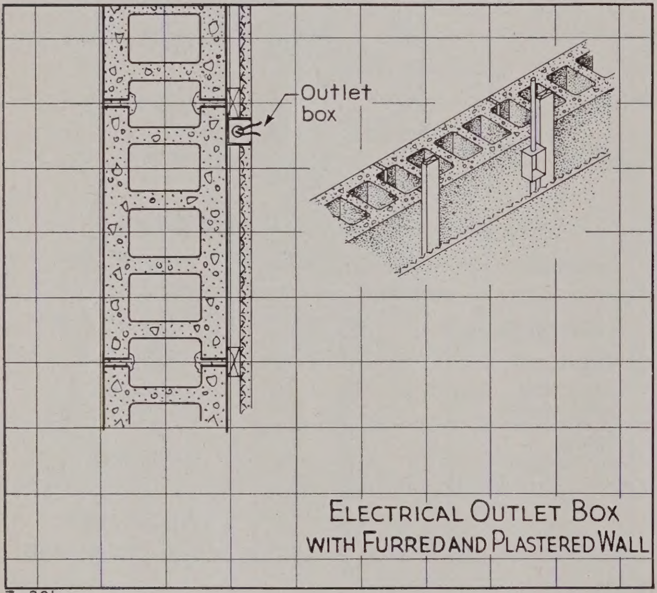

Calking
Metal clip
Precast concrete sill
Furring
Plaster
SILL FOR METAL CASEMENT WINDOW

Z-212


Conduit
Outlet box

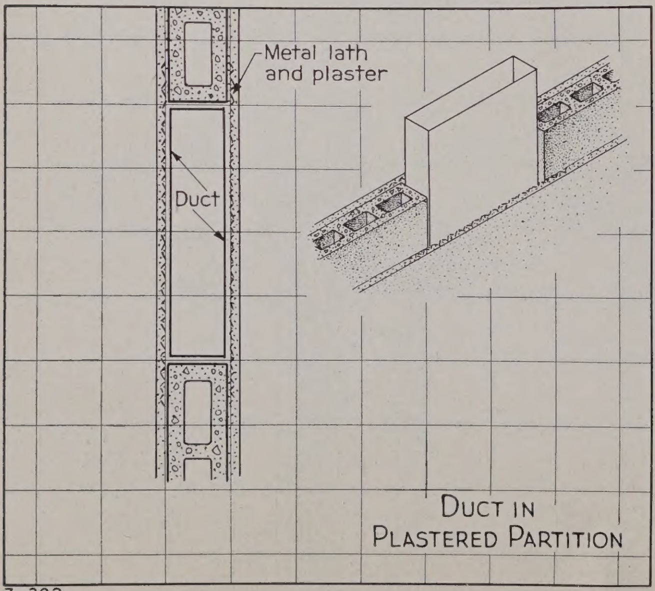
Electrical Outlet Box in Unplastered Wall

Z-300



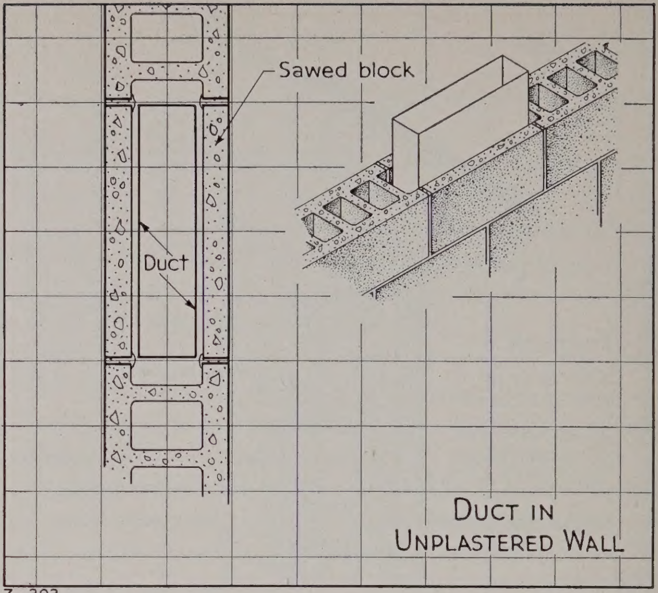
Electrical Outlet Box with Furred and Plastered Wall

Z-301


Metal lath and plaster
Duct

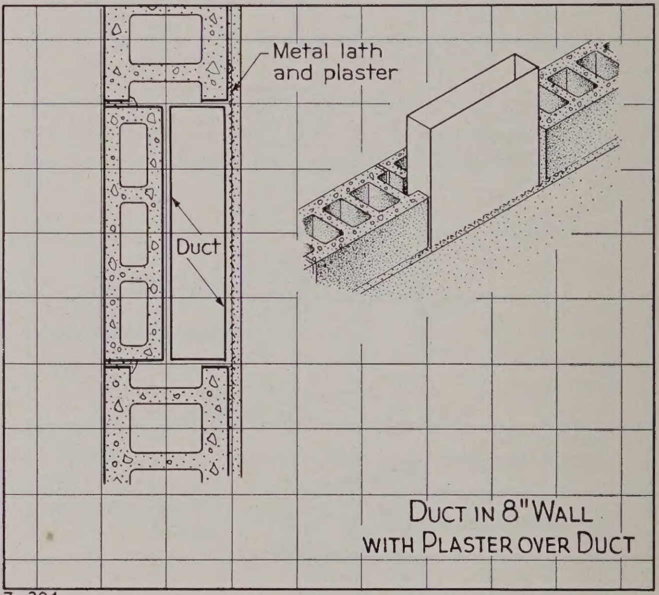
Duct in Plastered Partition

Z-302


Sawed block
Duct

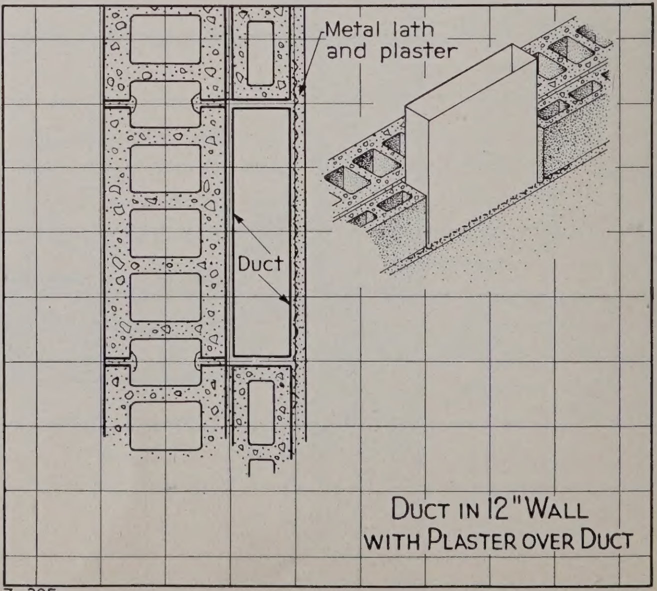
Duct in Unplastered Wall

Z-303


Metal lath and plaster
Duct

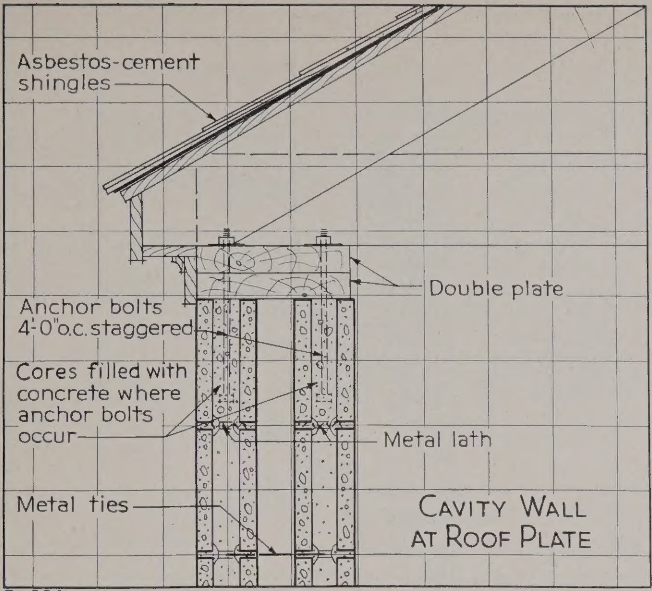
Duct in 8" Wall with Plaster over Duct

Z-304


Metal lath and plaster
Duct

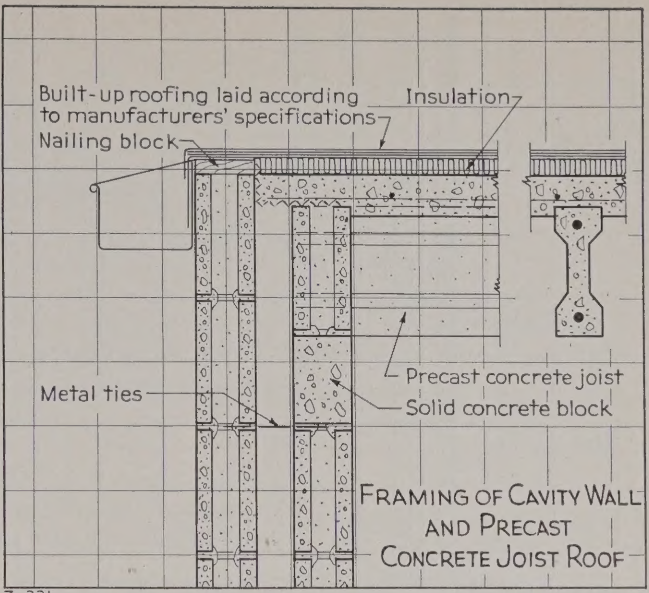
Duct in 12" Wall with Plaster over Duct

Z-305


Asbestos-cement shingles
Double plate
Anchor bolts 4'-0" o.c. staggered
Cores filled with concrete where anchor bolts occur
Metal lath
Metal ties

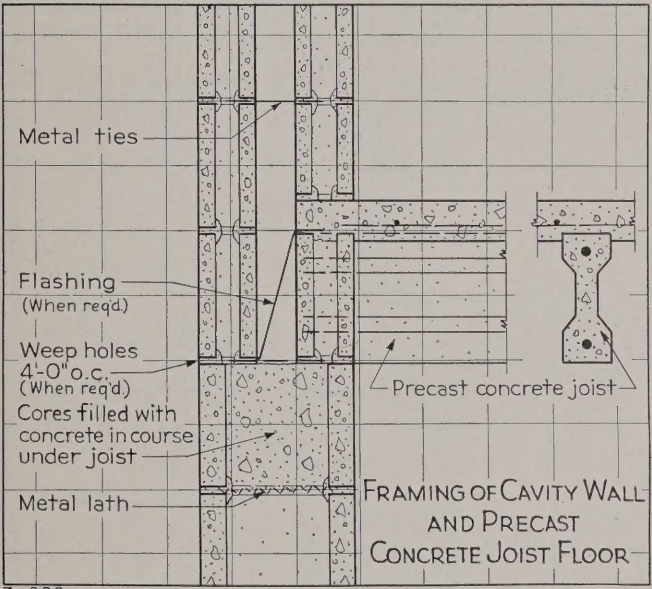
CAVITY WALL AT ROOF PLATE

Z-330


Built-up roofing laid according to manufacturers' specifications
Insulation
Nailing block
Metal ties
Precast concrete joist
Solid concrete block

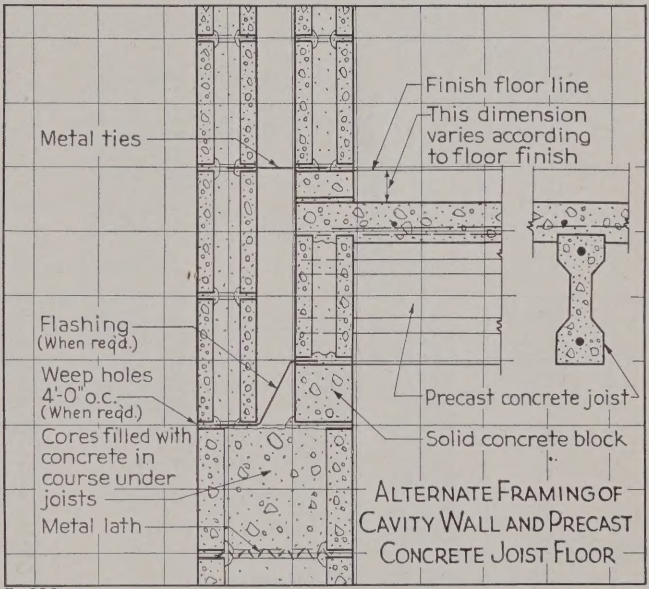
FRAMING OF CAVITY WALL AND PRECAST CONCRETE JOIST ROOF

Z-331


Metal ties
Flashing (When req'd.)
Weep holes 4'-0" o.c. (When req'd.)
Cores filled with concrete in course under joist
Metal lath
Precast concrete joist

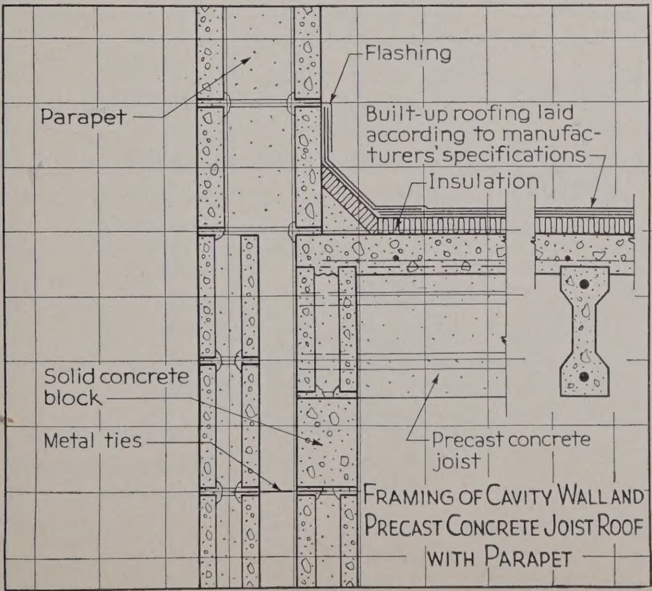
FRAMING OF CAVITY WALL AND PRECAST CONCRETE JOIST FLOOR

Z-333


Finish floor line
This dimension varies according to floor finish
Metal ties
Flashing (When req'd.)
Weep holes 4'-0" o.c. (When req'd.)
Cores filled with concrete in course under joists
Metal lath
Precast concrete joist
Solid concrete block

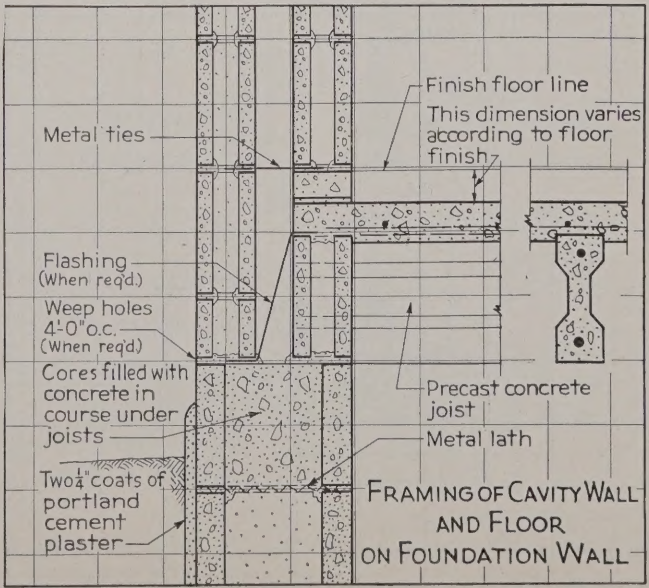
ALTERNATE FRAMING OF CAVITY WALL AND PRECAST CONCRETE JOIST FLOOR

Z-335


Flashing
Parapet
Built-up roofing laid according to manufacturers' specifications
Insulation
Solid concrete block
Metal ties
Precast concrete joist

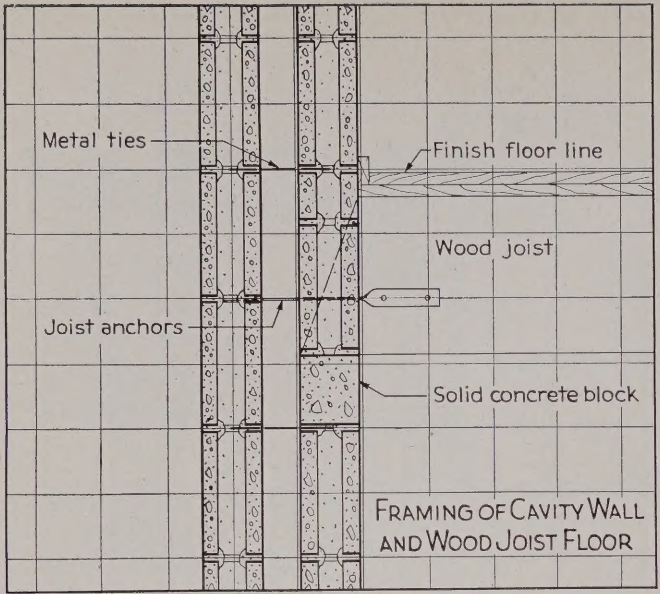
FRAMING OF CAVITY WALL AND PRECAST CONCRETE JOIST ROOF WITH PARAPET

Z-332


Finish floor line
This dimension varies according to floor finish
Metal ties
Flashing (When req'd.)
Weep holes 4'-0" o.c. (When req'd.)
Cores filled with concrete in course under joists
Two 1/4" coats of portland cement plaster
Precast concrete joist
Metal lath

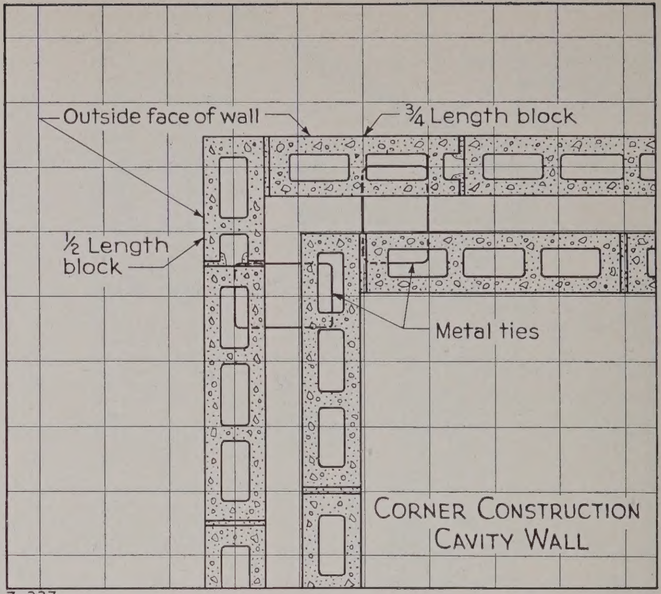
FRAMING OF CAVITY WALL AND FLOOR ON FOUNDATION WALL

Z-334


Metal ties
Finish floor line
Wood joist
Joist anchors
Solid concrete block

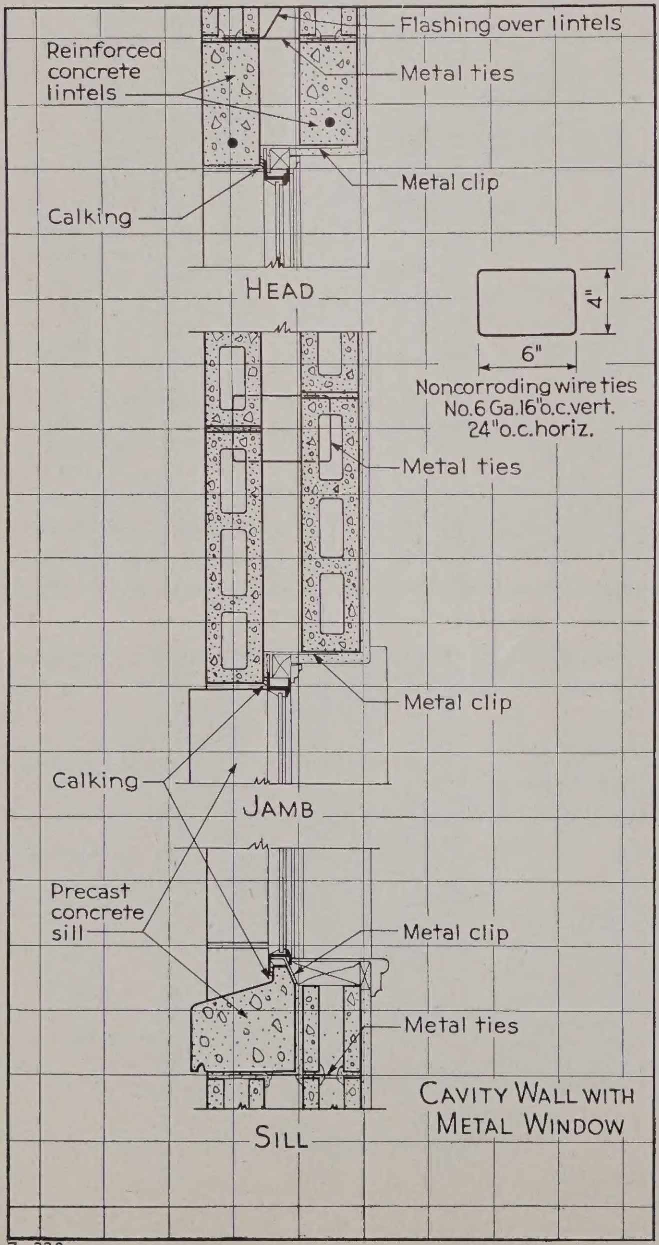
FRAMING OF CAVITY WALL AND WOOD JOIST FLOOR

Z-336


Outside face of wall
¾ Length block
½ Length block
Metal ties

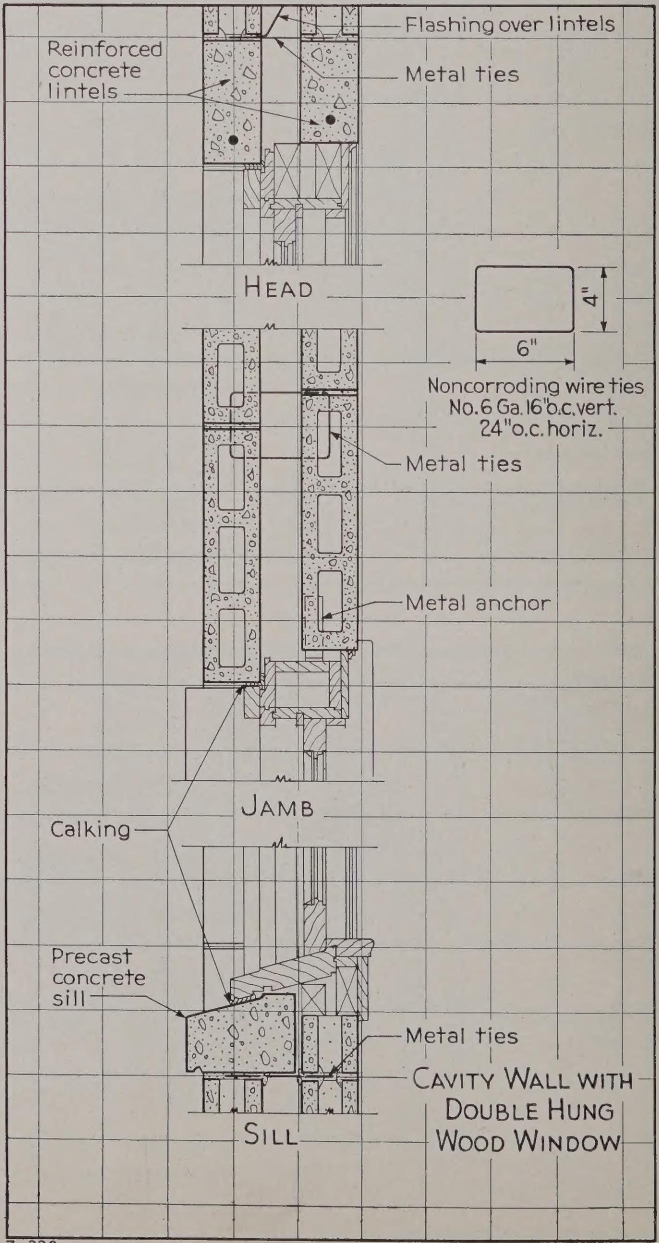
CORNER CONSTRUCTION CAVITY WALL

Z-337


Flashing over lintels
Reinforced concrete lintels
Metal ties
Metal clip
Calking
HEAD
4"
6"
Noncorroding wire ties No.6 Ga.16"o.c.vert. 24"o.c.horiz.
Metal ties
Metal clip
Calking
JAMB
Precast concrete sill
Metal clip
Metal ties
SILL

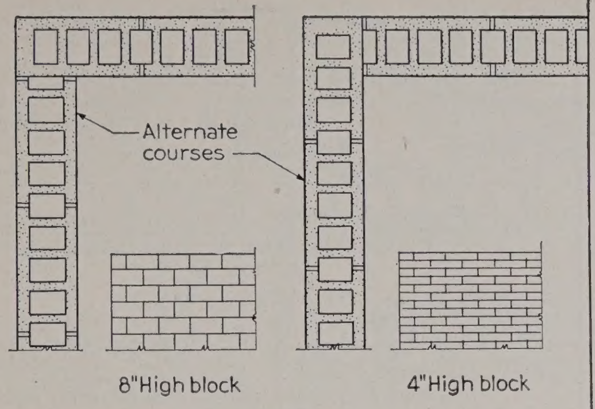
CAVITY WALL WITH METAL WINDOW

Z-339


Flashing over lintels
Reinforced concrete lintels
Metal ties
HEAD
4"
6"
Noncorroding wire ties No.6 Ga.16"o.c.vert. 24"o.c.horiz.
Metal ties
Metal anchor
JAMB
Calking
Precast concrete sill
Metal ties
SILL

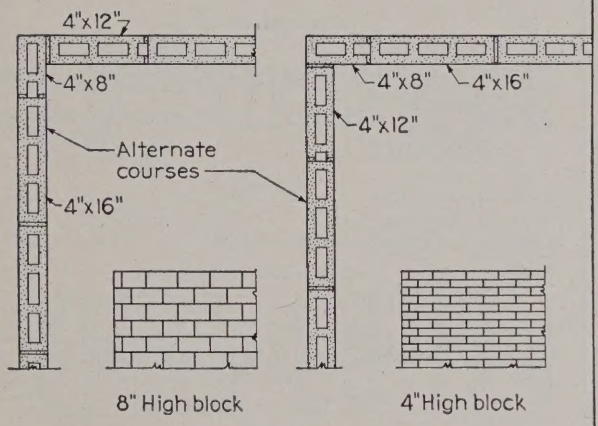
CAVITY WALL WITH DOUBLE HUNG WOOD WINDOW

Z-338


Alternate courses
8"High block
4"High block

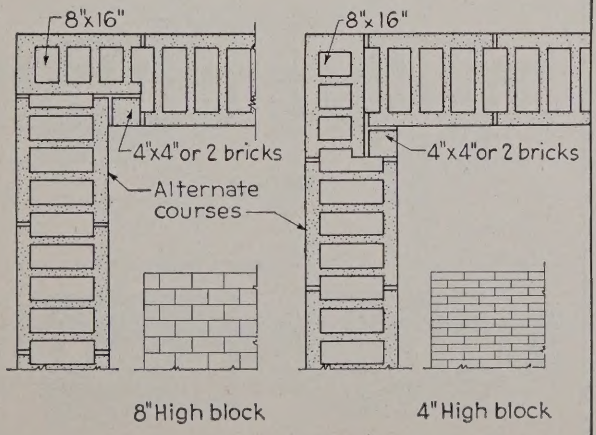
CORNER CONSTRUCTION FOR 8"x8"x16" AND 8"x4"x16" BLOCK

Z-87


4"x12"
4"x8"
Alternate courses
4"x16"
4"x8"
4"x16"
4"x12"
8" High block
4"High block

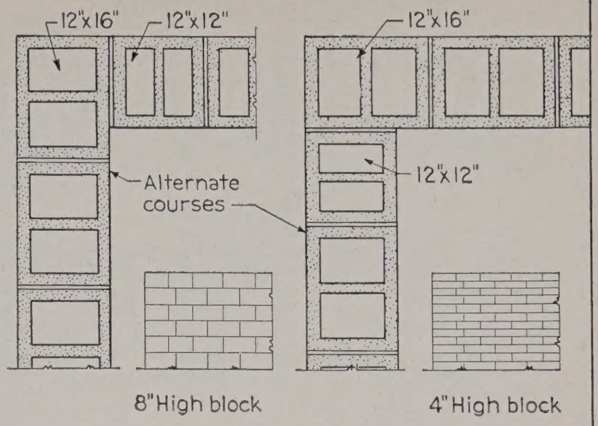
CORNER CONSTRUCTION FOR 4"x8"x16" AND 4"x4"x16" BLOCK

Z-88


8"x16"
4"x4"or 2 bricks
Alternate courses
8"x 16"
4"x4"or 2 bricks
8"High block
4"High block

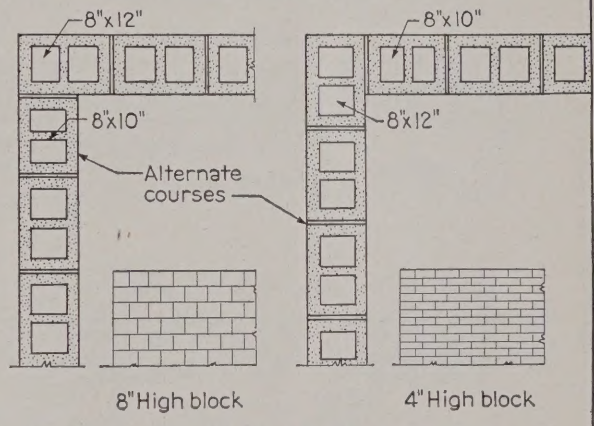
CORNER CONSTRUCTION FOR 12"x8"x16" AND 12"x4"x16" BLOCK

Z-89


12"x16"
12"x12"
12"x16"
12"x12"
Alternate courses
8"High block
4" High block

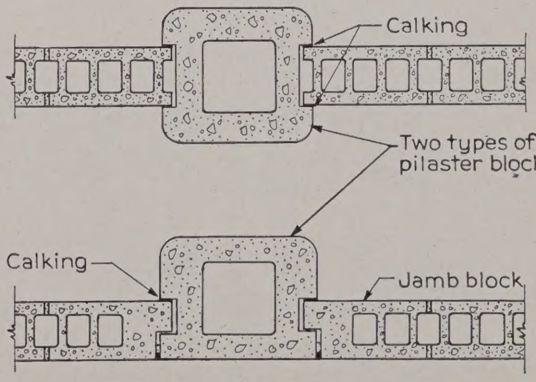
CORNER CONSTRUCTION FOR 12"x8"x16" AND 12"x4"x16" BLOCK

Z-90


8"x12"
8"x10"
8"x10"
8"x12"
Alternate courses
8"High block
4"High block

CORNER CONSTRUCTION FOR 8"x8"x12" AND 8"x4"x12" BLOCK

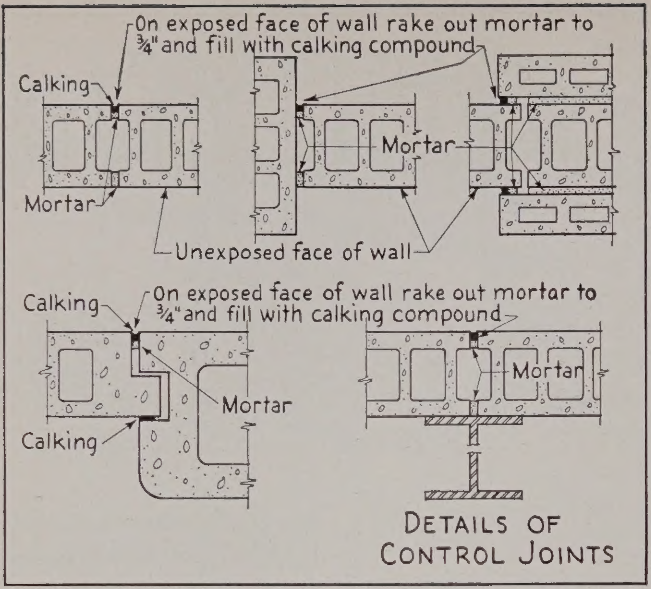
Z-91


Calking
Two types of pilaster block,
Calking
Jamb block

For control joint details see Dwg.Z-383

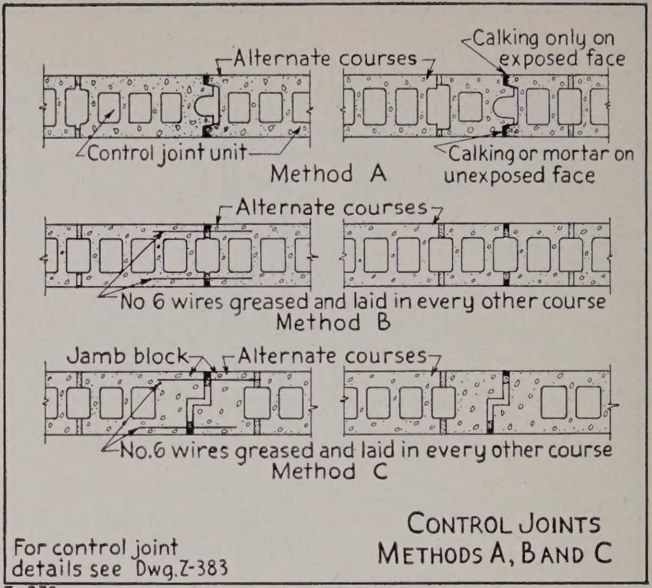
PILASTER BLOCK WITH CONTROL JOINTS

Z-375


On exposed face of wall rake out mortar to ¾" and fill with calking compound
Calking
Mortar
Mortar
Unexposed face of wall
Calking
On exposed face of wall rake out mortar to ¾" and fill with calking compound
Mortar
Calking
Mortar

DETAILS OF CONTROL JOINTS

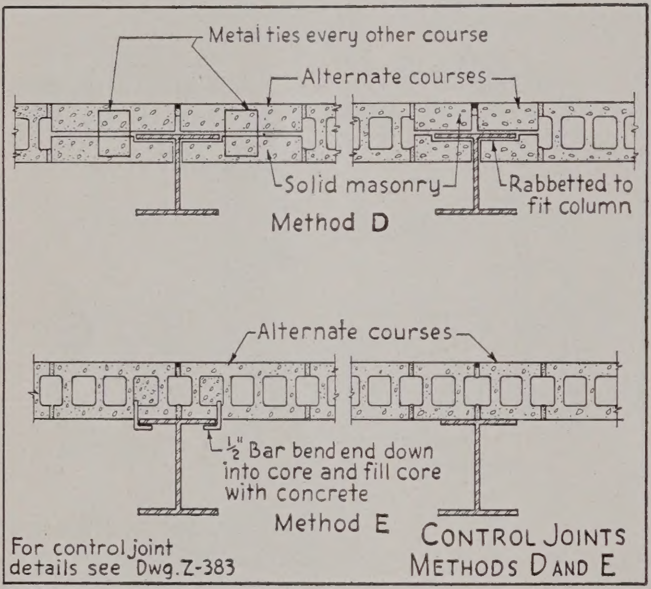
Z-383


Alternate courses
Calking only on exposed face
Control joint unit
Method A
Calking or mortar on unexposed face
Alternate courses
No 6 wires greased and laid in every other course
Method B
Jamb block
Alternate courses
No.6 wires greased and laid in every other course
Method C

For control joint details see Dwg.Z-383

CONTROL JOINTS METHODS A, B AND C

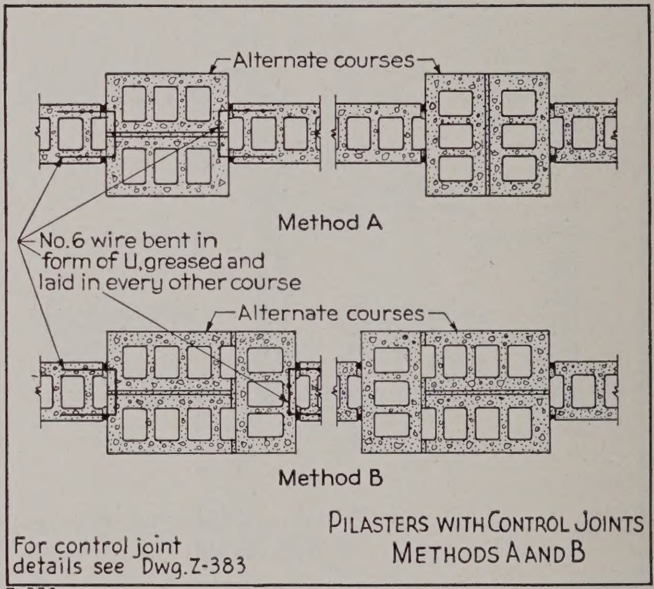
Z-376


Metal ties every other course
Alternate courses
Solid masonry
Rabbetted to fit column
Method D
Alternate courses
½" Bar bend end down into core and fill core with concrete
Method E

For control joint details see Dwg.Z-383

CONTROL JOINTS METHODS D AND E

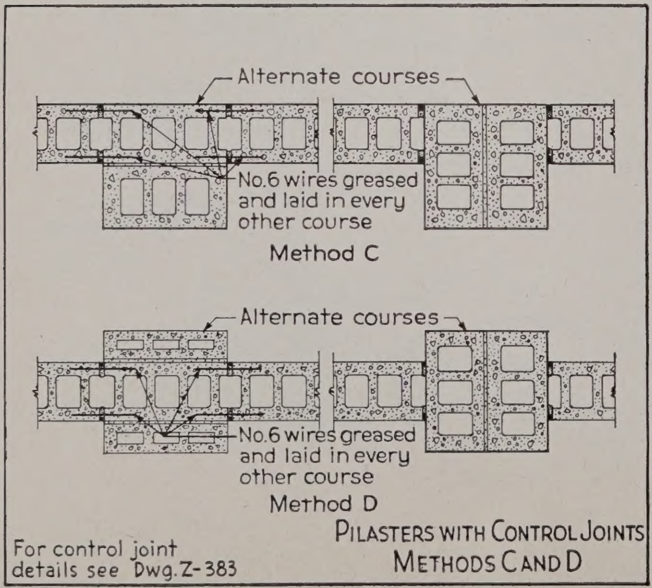
Z-382


Alternate courses
Method A
No.6 wire bent in form of U, greased and laid in every other course
Alternate courses
Method B

For control joint details see Dwg.Z-383

PILASTERS WITH CONTROL JOINTS METHODS A AND B

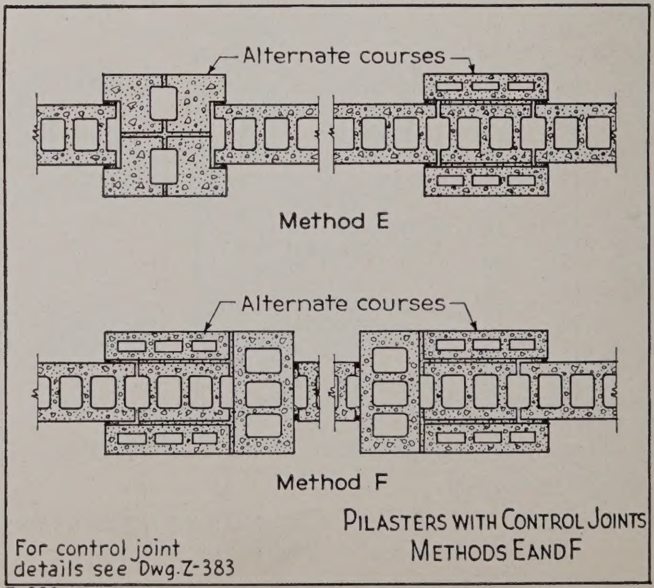
Z-378


Alternate courses
No.6 wires greased and laid in every other course
Method C
Alternate courses
No.6 wires greased and laid in every other course
Method D

For control joint details see Dwg.Z-383

PILASTERS WITH CONTROL JOINTS METHODS C AND D

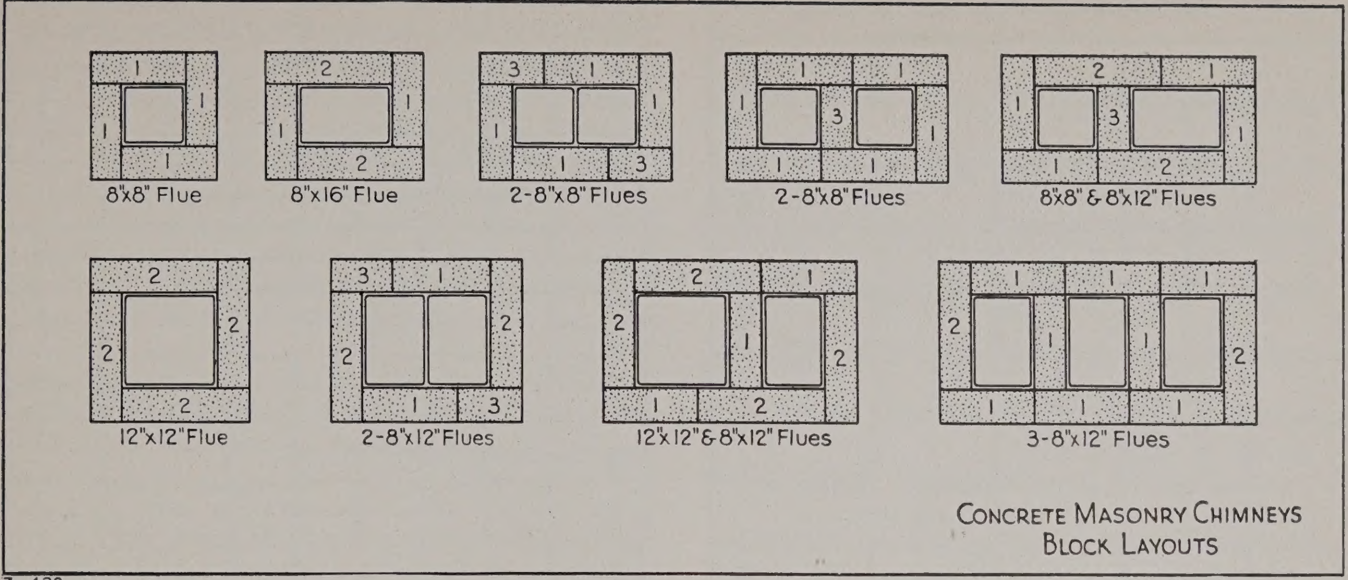
Z-379


Alternate courses
Method E
Alternate courses
Method F

For control joint details see Dwg.Z-383

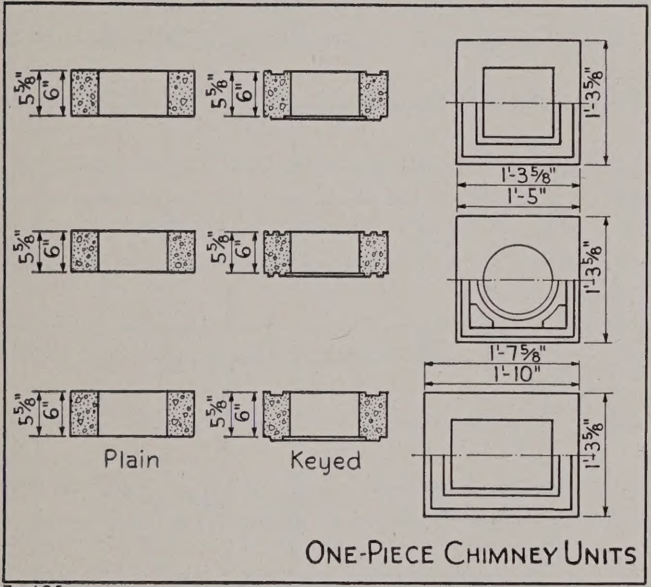
PILASTERS WITH CONTROL JOINTS METHODS E AND F

Z-380


8"x8" Flue
8"x16" Flue
2-8"x8" Flues
2-8"x8" Flues
8"x8" & 8"x12" Flues
12"x12" Flue
2-8"x12" Flues
12"x12" & 8"x12" Flues
3-8"x12" Flues

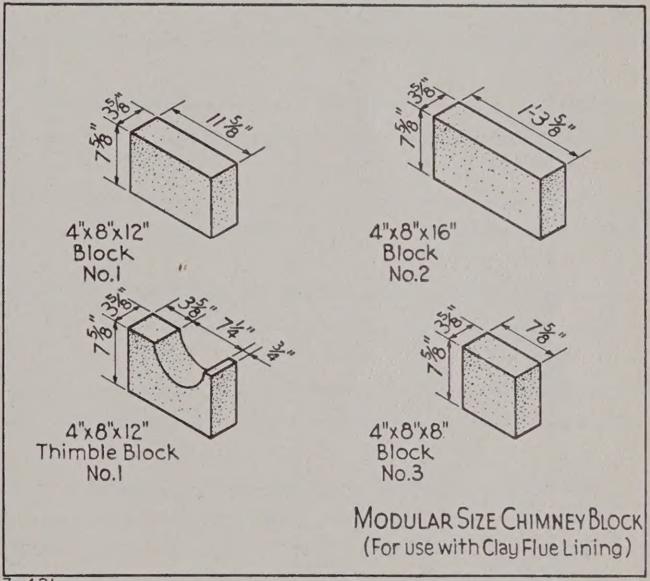
CONCRETE MASONRY CHIMNEYS
BLOCK LAYOUTS

Z-420


5⅝"
6"
Plain
Keyed
1'-3⅝"
1'-3⅝"
1'-5"
1'-3⅝"
1'-7⅝"
1'-10"
1'-3⅝"

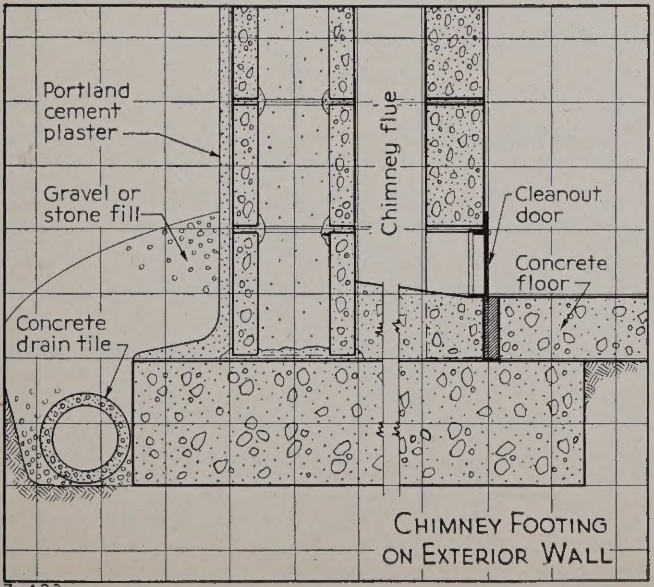
ONE-PIECE CHIMNEY UNITS

Z-425


3⅝"
11⅝"
7⅝"
4"x8"x12"
Block
No.1
3⅝"
1'-3⅝"
7⅝"
4"x8"x16"
Block
No.2
3⅝"
3⅝"
7¼"
¾"
7⅝"
4"x8"x12"
Thimble Block
No.1
3⅝"
7⅝"
7⅝"
4"x8"x8"
Block
No.3

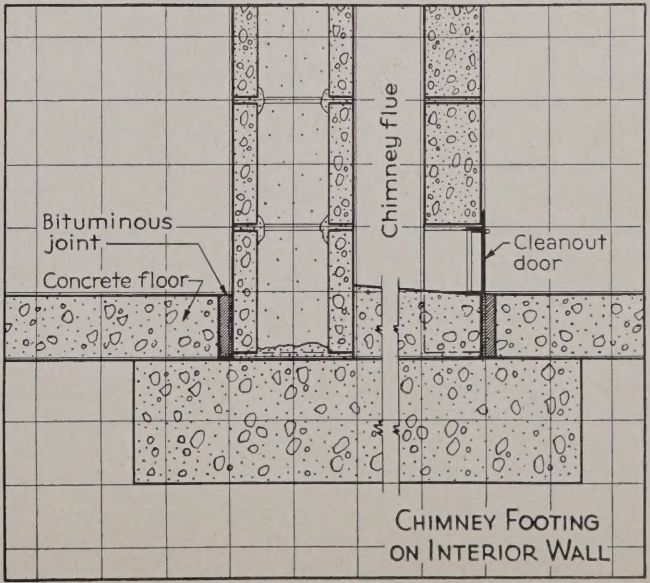
MODULAR SIZE CHIMNEY BLOCK
(For use with Clay Flue Lining)

Z-421


Portland cement plaster
Gravel or stone fill
Concrete drain tile
Chimney flue
Cleanout door
Concrete floor

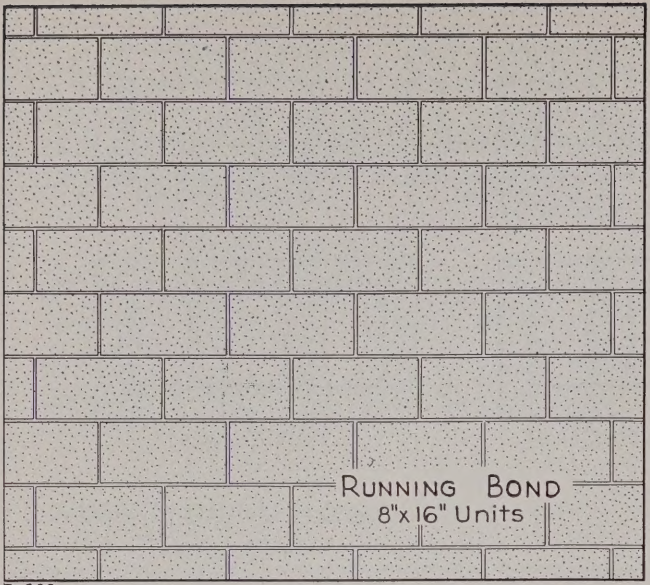
CHIMNEY FOOTING
ON EXTERIOR WALL

Z-423

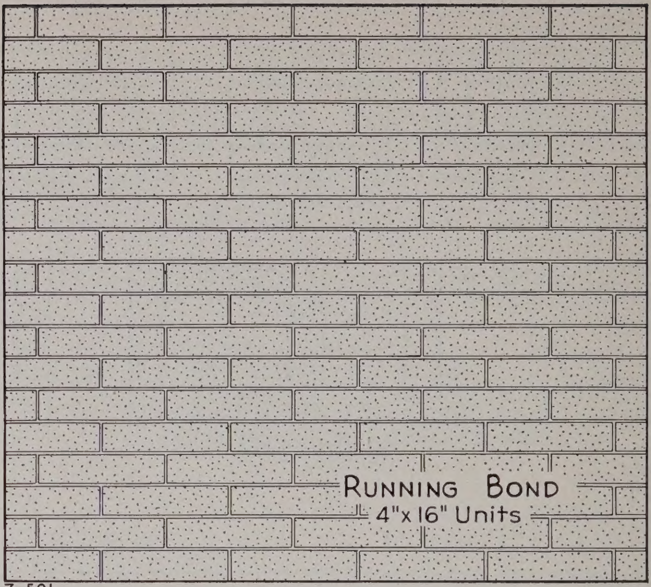

Bituminous joint
Concrete floor
Chimney flue
Cleanout door

CHIMNEY FOOTING
ON INTERIOR WALL

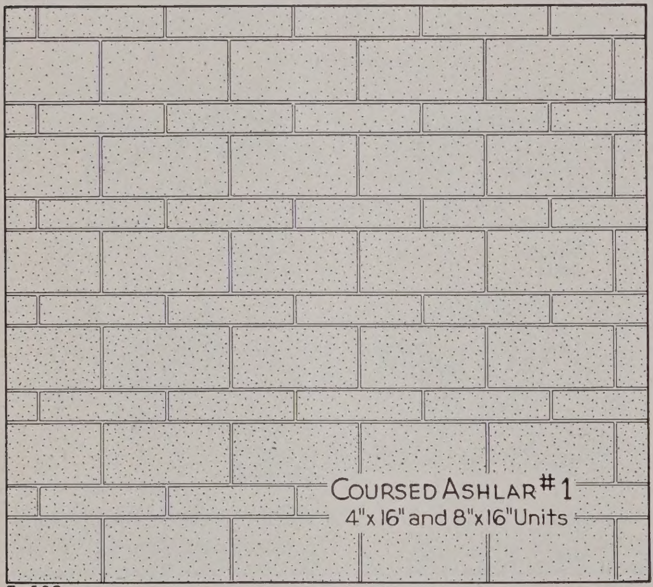
Z-424


RUNNING BOND
8"x 16" Units

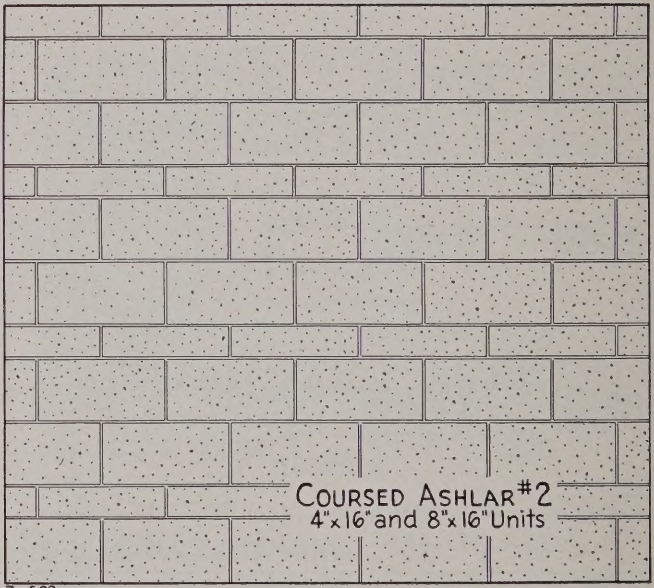
Z-500


RUNNING BOND
4"x 16" Units

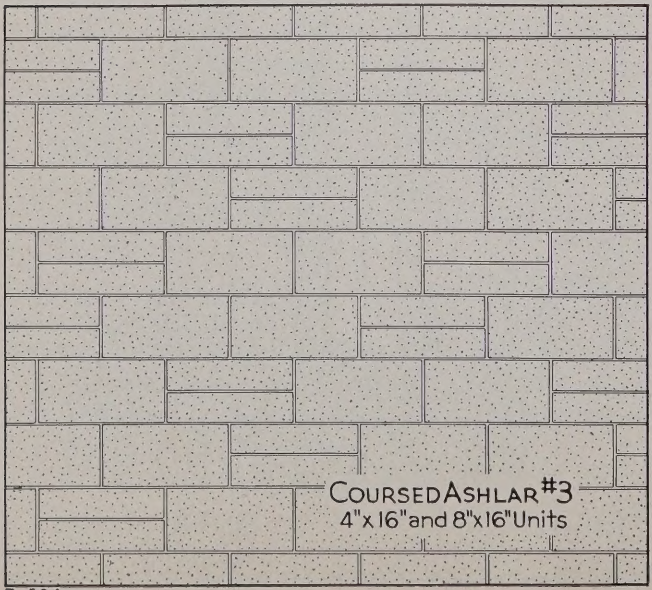
Z-501


COURSED ASHLAR #1
4"x 16" and 8"x 16" Units

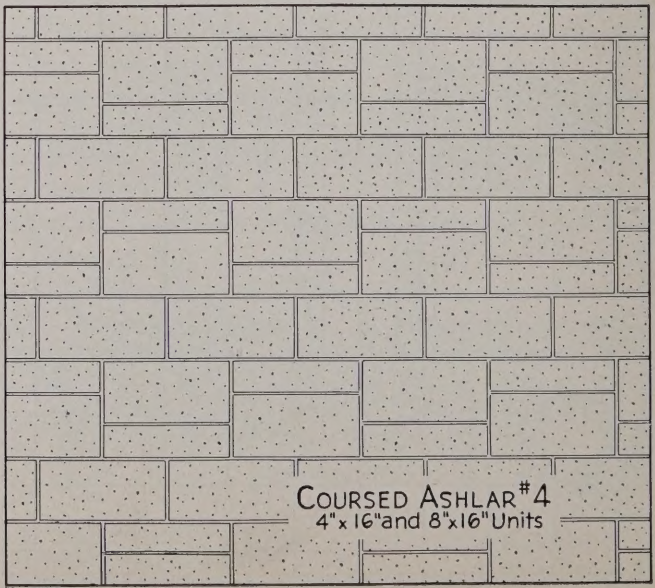
Z-502


COURSED ASHLAR #2
4"x 16" and 8"x 16" Units

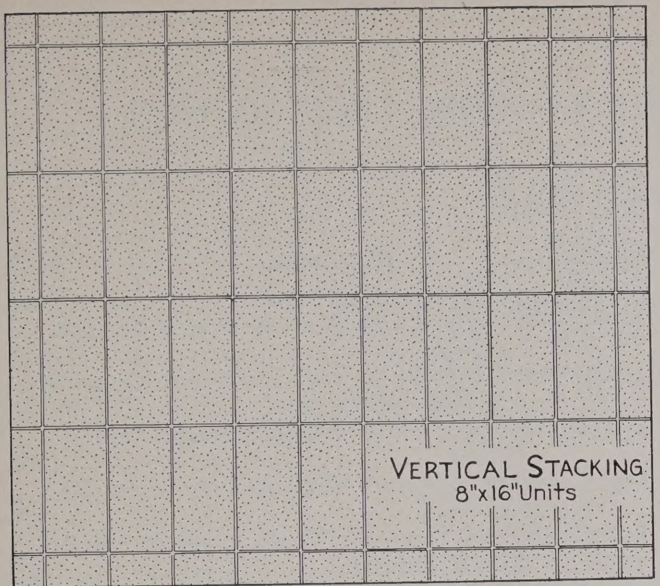
Z-503


COURSED ASHLAR #3
4"x 16" and 8"x 16" Units

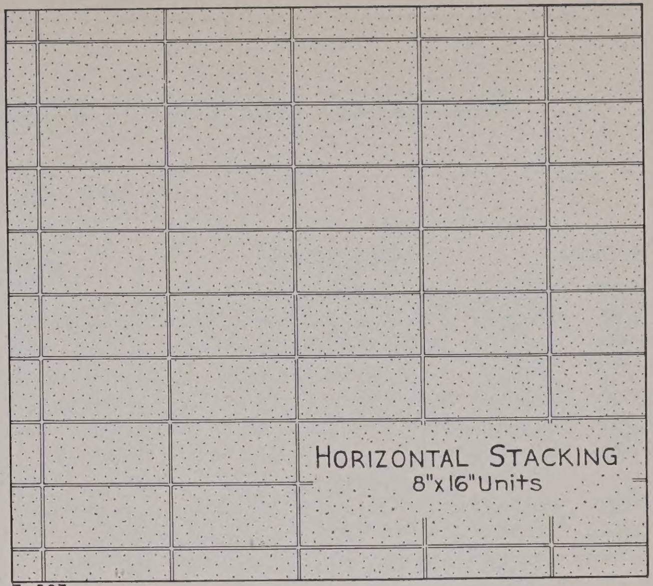
Z-504


COURSED ASHLAR #4
4"x 16" and 8"x 16" Units

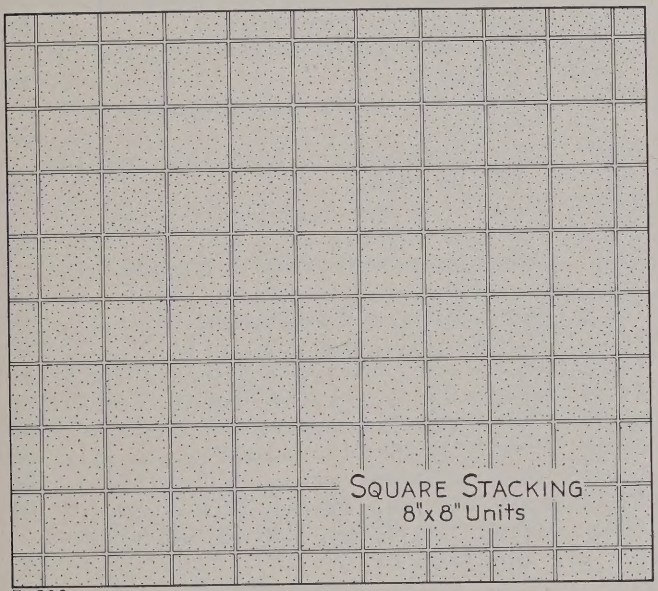
Z-505


VERTICAL STACKING
8"x16"Units

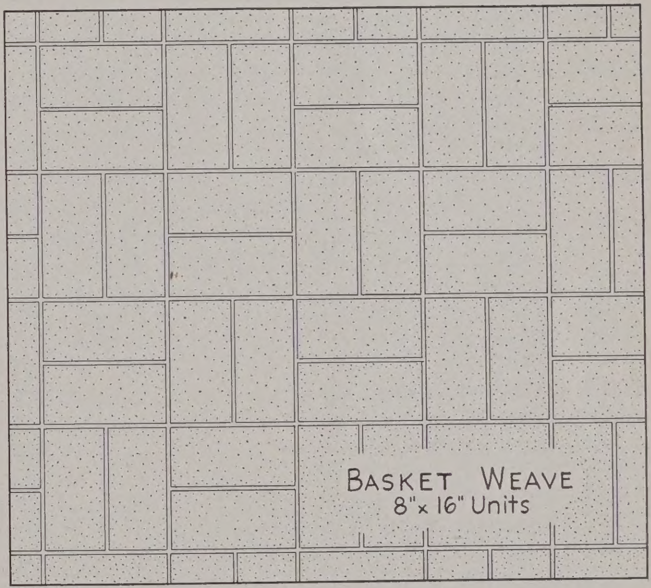
Z-506


HORIZONTAL STACKING
8"x16"Units

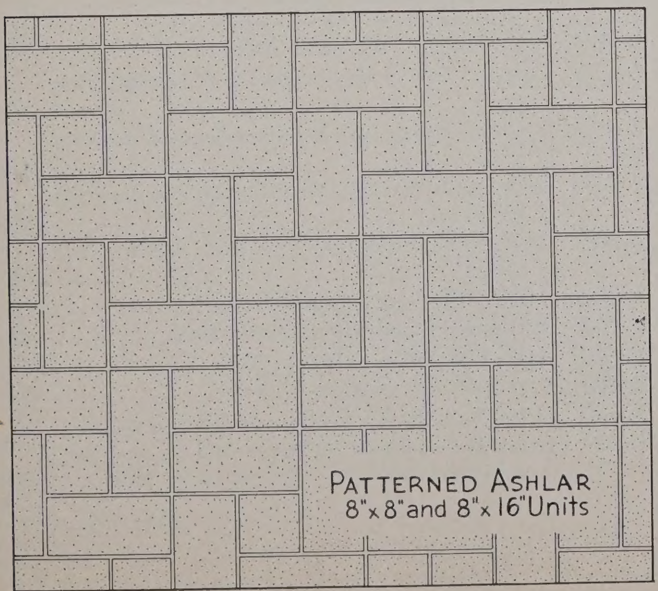
Z-507


SQUARE STACKING
8"x8" Units

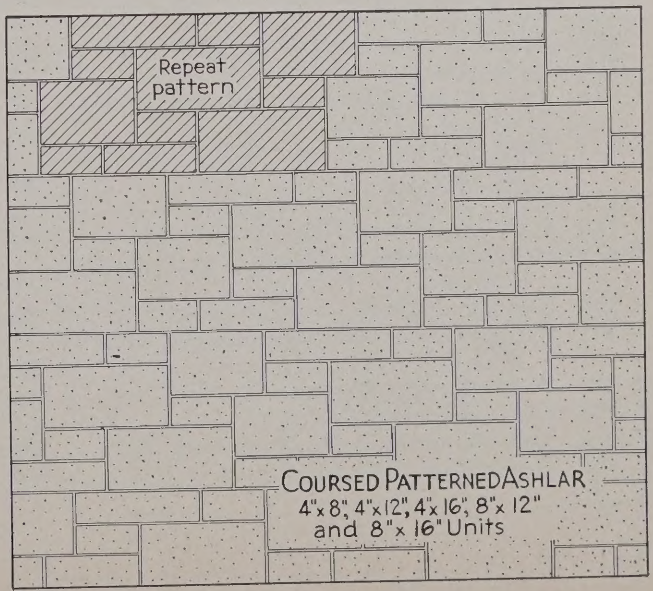
Z-508


BASKET WEAVE
8"x 16" Units

Z-509


PATTERNED ASHLAR
8"x 8" and 8"x 16" Units

Z-510



COURSED PATTERNED ASHLAR
4"x 8", 4"x 12", 4"x 16", 8"x 12"
and 8"x 16" Units

Z-511

SUGGESTED DETAILS OF CONCRETE MASONRY CONSTRUCTION

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